SCIENTIFIC AMERICAN

AUSTRIAN OFFICERS NOTING THE EFFECT OF GUN FIRE

Pictures of the European Armies

Onnes' Discovery of a Perpetual Current Without Electromotive Force

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

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The Command of the Sea

THUS far, the most important lesson taught by the great European war is the supreme importance of the command of the sea. A few days ago, the German fleet, most formidable in numbers and second to none in its fighting qualities, was free to steam where it would upon the high seas, and the flag of its merchant marine was flown on every ocean and in every great port of the world. To-day, the German battle fleet is shut up in the Baltic, its cruisers, harried by the more powerfully armed ships of the allies to establish the supreme command of the sea, for want of coal, and the ships of its truly magnificent merchant marine are either sheltering in neutral ports, or are being led as captures to the home ports of the enemy.

Furthermore, so swift have been the navies of the allies to establish the supreme command of the sea, that already, within two weeks of the declaration of war, Great Britain has been able to notify her merchant fleet that the customary routes of travel have been cleared of the enemy; and she holds the North Sea so completely in her hand that already she has landed over 100,000 troops upon the German right flank in Belgium.

To our minds the most convincing proof of the cataclysmic nature of the present upheaval in Europe is to be found in the fact, that the opening of the war found both the German navy and its vast merchant marine totally unprepared for the emergency. If it does not prove that, at least it proves that Germany had not the slightest expectation that the British navy would be brought into the conflict. Had there been the slightest suspicion, at Berlin, that the violation of the neutrality of Belgium would have brought the whole British Empire to the relief of that little kingdom, it is certain that some provision would have been made for the recall of German cruisers on distant stations, and for the withdrawal of the richer prizes of the German merchant marine to the home ports of the empire.

For many a long decade to come and, indeed, until the secret and inner history of the war shall have been disclosed, it will be a profound mystery that Germany should have so ruthlessly sacrificed the far-flung fleet of her great merchant marine. For among the many great things that Germany has done in the last forty years, there is nothing finer than the zeal, ability, and brilliant success with which she has built up her merchant fleet and strung out her world-engirdling lines of foreign commerce. Hence the wonder of it all, that rather than sacrifice a pre-arranged strategical line of attack upon the enemy, Germany should have submitted to the absolute wiping out of the wonderful system of ships and commerce which she had so patiently built up through the past fifty years of her existence.

For the United States, this tragedy (for it is nothing less) carries an obvious lesson. There is every probability that the conclusion of this war will find us in the possession of a numerous and well-equipped merchant marine; and if we are wise to pay heed to a warning which is so plainly written that "he who runs may read," we shall see to it that our naval strength is increased in such proportions, that such a disaster as has swept away the great German merchant marine can never overtake our own.

A Real Test for Military Aircraft

THE terrible conflict in which the greater part of Europe is now engaged will probably serve to fix the military status of the dirigible and the aeroplane. Aircraft are still military enigmas. No one can pretend that the desultory use of the flying machine during the Morocco and Balkan campaigns disclosed its possibilities and limitations in war. Indeed, the dirigible has not yet been thoroughly tested in anything like a real battle.

Of the value of the flying machine for scouting there can be no question. Bloody as the present war may prove to be, it is not likely that we shall see a German army plunging into a whole French center, under the impression that it is a mere retreating rear guard—a blunder which cost the Germans thousands and thousands of men during the war of 1870-1871 at Vionville and Gravelotte, and which might have terminated disastrously, had it not been for the stolid and unwavering bravery of the German troops in action. Nor are we likely to see a 203-meter hill captured, lost and recaptured again and again, not for the purpose of planting guns upon it in order to shell a beleagured Port Arthur, but for the purpose of stationing on its crest scouts, whose telescopes may discern how effective was the fire of a fleet that could not see its target. Aircraft may prove instruments of mercy; for the aeroplane and dirigible have miraculously transported the all-seeing eye of a commanding officer to a height where the whole terrane lies spread out before him like a vast topographical map on which an enemy's every battery may be seen. Information which could hitherto be gleaned only by a reconnaissance in force at a cost of human life too terrible to contemplate, will now be obtained by a few pilots wheeling high in the air on high-powered machines.

But it stands to reason that a general will not permit this bird-like scrutiny of his position without attempting to thwart it in some way. Both in Morocco and in the Balkans, rifle fire was relied upon, not altogether with success, to drive off inquisitive aviator officers. In the Balkans, two pilots were killed in this manner; but on the whole, rifle fire seems only to have sent the scout to a higher level, where observation, while not so easy, was at least fairly safe. Both the Germans and the French have developed special artillery for the purpose of assailing reconnoitering aircraft. The effectiveness of this ordnance is doubtful against machines speeding along at a height of 5,000 feet and more at the rate of at least 60 miles an hour.

Can it be then that in sheer self-defense reconnoitering aeroplanes will be fought off in the air itself? Will a commander who seeks to mask his movements and his defenses pit his aeroplanes against those of his enemy? In other words, are we likely to see real battles in the air? The fact that military flying machines have latterly been armored and provided with light machine guns, would seem to indicate that some such possibility exists. That the giant Zeppelins of the German army are expected to fight has long been known. They too have been both armed and armored. Their speed has been increased to over 60 miles an hour, obviously for the purpose of enabling them to cope with the swift aeroplane.

The relation of the dirigible to the aeroplane is not clear. The war will probably decide that moot point. Perhaps dirigible and aeroplane will stand to each other in much the same relation as battleship to torpedo boat. It is conceivable that a whole flock of aeroplanes may be sent to annihilate a single dirigible and conceivable too that, thanks to its superior armament and its great speed, a Zeppelin may successfully fight off such an attack. Heroic officers can probably be found to attempt the ramming of a formidable airship—a feat which rumor with untruthful picturesqueness attributed to Roland Garros at the outbreak of the present conflict, and which was unintentionally accomplished with frightful results during the last Austrian maneuvers. It may be doubted if a flying machine could ever approach another aircraft closely enough in the face of machine gun fire, unless it be under exceptional circumstances. Naval strategists have long since abandoned the ram, for much the same reason.

It may be that the dirigible's chief effectiveness may lie in bomb dropping. Despite the questionable success of the dropped bomb in Morocco and in the Balkans, more may be expected of it in the hands of the trained French and German pilots. It is not unlikely that new ways of dropping explosives may be disclosed. Who knows but sudden night attacks may be made, in which a flying machine may swoop down out of the blackness, release its deadly load and leap up again? The feat is not utterly impossible despite searchlights, and the moral effect on the attacked force would be tremendous.

That tactics and strategy will be modified may be expected. New methods of masking movements will probably be invented—that much may be deduced from the annual maneuvers conducted in Europe.

The Great Paradox

THE huge war now raging in Europe is the inevitable outcome of the unsymmetrical development of the mind of man. Perhaps the leading country of the world in the sciences and the arts is Germany. Certainly the leading country in the world in developing an aggressive and militarist policy is Germany. She is at once the most enlightened and the most reactionary of the greater nations of the earth. She is, above all other countries, the living embodiment of that monstrous paradox we call the advancement of science. Our progress in the control of nature for the benefit of mankind has been equalled only by the splendid intelligence with which we have perfected means of slaying one another. We learn how to abolish a disease and simultaneously invent a dreadnought. As scientific men, while half of us work for the establishment of heaven upon earth, the other half strengthens the possibilities of an increasingly ghastly hell. We approach the millennium and Armageddon along parallel roads.

This towering paradox will now be resolved. The destructive half of mankind have beaten their brethren in the race. The war lords triumph over the apostles of peace. For the moment the service of the devil takes precedence over the service of God. But only for the moment. Clever and energetic as they have been, the destroyers have not been clever and energetic enough. The foundations of peace are too firmly laid. The fear that civilization is now rocking to its fall is a fear without justification. The war will progress from horror to horror and with it the disgust and anger of the people will deepen. The *foolishness* of war! More and more will this thought permeate the consciousness of the whole world. Already this view is clearly expressed by countless men throughout Europe. As they suffer more they will see more clearly, and when this war ends there will be no more wars. We are not witnessing the triumph of the destroyers. We are witnessing their vast collective suicide. As ruthless as they have been in war, so shall we be ruthless for peace. At present we play their game: we fight, because fight we must. But after —— there shall be no more war lords. The paradox will be resolved. Science shall no longer ignobly serve the forces of destruction, but, released from this dire bondage, shall bend all its energies to the task of making this fair world more beautiful and more secure. The savage, trained and equipped, shall no longer preside at our councils. His day is over. His last and greatest attempt at dominance shall result in his utter overthrow and destruction, whatever be his nationality; and the race of the future will be a race of civilized men, united by the bonds of mutual interest and appreciation and developing their powers in concord in the security accorded by an agreed and permanent world-peace.

Our European War Number

WITH a view to answering the thousand-and-one questions which are being asked regarding the European war, the SCIENTIFIC AMERICAN will issue, on September 5th a special war number of at least forty pages. This issue will be similar in scope and the character of its information to the war number that we issued during the Spanish war, which so exactly met the public needs that the sale reached nearly half a million copies.

The issue will give the very latest estimate of the relative strength of the contending armies, and successive chapters will explain in detail how a great army is moved to the front, deployed in battle; kept in touch with the commander-in-chief; supplied with its daily rations and other supplies; and cared for and its wounded removed by the medical corps. Full details will be given of the armament of every nation engaged, including descriptions of the shoulder pieces, machine guns, field guns, and heavy guns for the reduction of fortifications.

The navy section will illustrate and describe the ships and guns of each navy engaged, and this section alone will contain over fifty illustrations of the principal dreadnoughts, battle-cruisers, etc., of each navy.

To enable the reader to follow, day by day, the progress of the war, the issue will contain two maps specially drawn for this purpose. The larger map in colors will cover the whole field of operations; the smaller map, drawn on a greatly enlarged scale, will cover the German-French frontier. It will show clearly the mountains, rivers, railways, principal forts, and cities, and other strategical features of this, the main battle ground of the war, thus enabling the reader to follow by means of colored flags the various moves of the forces engaged. The issue will be contained in a colored cover.

Engineering

Portland Cement in Peru.—Heretofore, Peru has derived its supplies of Portland cement entirely from abroad, large quantities being purchased in the United States, England and Belgium; but recently a company has been formed in Lima to undertake the manufacture of cement, suitable material being said to be plentiful.

Mineral Railways in Spain.—A number of short railways, ranging from twelve to seventy-four miles in length, have been projected in Spain to facilitate the shipment of ores, and several of them are already under construction. These lines are located in the region between Madrid and Cordoba, and will greatly promote the development of the rich mineral district in that part of the country

Wireless Phones Across the Sea.—While giving evidence before the Dominion's Royal Commission recently, Mr. Godfrey Isaacs declared that Marconi expects to establish wireless telephone communication between Carnarvon and New York as soon as certain mechanical details have been carried out at the home station, and he hopes that this will be done before the end of the year.

Railways in Manchuria.—Northern Manchuria is at present entirely dependent for its transportation facilities on a single railroad, the Chinese Eastern; but five important lines have been projected by Russia to meet the rapidly growing needs of this vast country. Another line, to cost $5,000,000, is being organized with Chinese capital, while two other lines have been the subject of negotiations between the Chinese and Japanese governments.

High-angle Field Artillery Guns.—The next design for U. S. field artillery guns will be provided with a split-trail gun carriage, which will permit the elevation of field artillery guns to almost any angle. The Army Ordnance Department is developing projectiles which will leave a trail of smoke by day and of light by night. It is believed that with such projectiles the range upon aeroplanes can be found, and an effective defense provided against an attack from overhead.

A Chinese Coal Mine.—A most successful industrial venture is the Chung Hsing Coal Mining Plant, at Yi Hsein, which is entirely under Chinese management. The mechanical equipment is of the most modern character, and most of the machinery came from German makers, although there are two American Baldwin locomotives in use. About three thousand men are employed, and the daily output is about 1,000 tons of good quality coal. The average wage paid is ten cents a day and board, which costs about $1 per man a month.

Railway Mileage.—The mileage of railways in Europe increased from 206,987 in 1910 to 212,651 in 1912; in America, from 326,357 to 343,643; in Asia, from 63,188 to 66,534; in Africa, from 22,850 to 26,491; in Australasia, from 19,229 to 21,678, and in the world, from 638,611 to 670,997. Of the 212,651 miles in Europe at the end of 1912, 98,952 were privately owned; 321,406 out of the 343,643 in America; 22,694 out of the 66,534 in Asia; 10,656 out of the 26,491 in Africa; 2,708 out of the 21,678 in Australasia, and 456,416 out of the 670,997 in the world.

Record for a 12-inch Army Gun.—It is stated that, recently, at the army proving grounds at Sandy Hook, all records with 12-inch guns were broken when a range of 20,000 yards, or over 11 miles was attained with 700-pound projectiles. This is the weight of shell used in the 12-inch mortars. According to the *Army and Navy Journal*, 11 miles is the limit of fire control, since it is not believed that any range finder can be developed which will make the fire of guns effective beyond this distance, the curvature of the earth rendering it impossible for range finders to locate an object at a greater distance.

Hydro-electric Enterprises in Germany.—Owing to the general level country in Germany there are at present few hydro-electric plants, one of the largest being that on the Rhine near Basel, where 40,000 horse-power is developed from a fall of seventeen feet. Just before the declaration of hostilities, it was announced that another plant, to develop at least 50,000 horse-power, would be erected at once at Walchensee, near Munich. The rates charged for electricity depend on the use to which the current is put; thus a 10 candle-power lamp used in bedroom, drawing room or warehouse costs $1.26 a year, while the same lamp in a living room, kitchen, office or work-shop will cost from $2.28 upward.

A New Mono-railway.—A plan for a suspended monorailway has been submitted to the Minister of Public Works in France by a French engineer, M. Mähl, on which, it is claimed, speeds of 150 miles an hour or so may be attained with safety. The track, either single or double, is to be carried 20 feet to 25 feet above the ground by catenary suspension. The train will be composed of small sections freely articulated, and will easily take curves of 1 kilometer radius and gradients of 1 in 20. It will be propelled, of course, by electricity. Each section of the train will be suspended from two wheels placed about 1 meter apart. The seats will be placed longitudinally, and there will be but a single row of them.

Electricity

Indicating Fuse Plugs.—A new fuse plug has been put on the market which is provided with an indicating pin that is driven out through the porcelain cap of the plug by a spring when a blowout occurs. This enables one to determine at a glance which plug has blown out. Even in the dark, one can tell readily by sense of touch which plug needs to be replaced.

Electric Vehicle and the Parcels Post.—The Electric Vehicle Association of America has compiled some interesting parcels post statistics with a view to promoting the use of the electric vehicle in this branch of government service. In fifty cities, having a combined population of 20,000,000, 11,000,000 parcels were mailed, and 3,500,000 parcels were received, for local delivery, from October 1st to October 15th last year. They weighed, on the average, one pound and eleven ounces, and paid 10 cents postage each. Three quarters of this mail was handled by regular carriers, and about 10 per cent, or 350,000 parcels, were delivered by automobiles, at a cost of $17,653.

Telephony in America.—On January 1st, 1914, there were 13,700,000 telephones in the world, and 32,900,000 miles of telephone wire. This country, with 9,000,000 stations, owned 66 per cent of the total number in the world; while Europe, with less than 4,000,000, owned about 27 per cent. When we consider that the population of the United States is but six per cent of the world's population, and less than 25 per cent of that of Europe, our large proportion of telephone stations makes a remarkable showing. New York city alone has more telephones than Belgium, Hungary, Italy, Netherlands, Norway and Switzerland combined; there are more telephones in Chicago than in the whole of France, and more in Philadelphia than in the whole of Austria.

Electrolytic Disinfecting Fluid.—The use of electrolyzed sea water for disinfecting purposes in hospitals, public baths, schools, etc., in the borough of Poplar, London, has proved a great success. According to the recent report of Dr. Alexander, the output last year was 66,720 gallons, showing an increase of over 12,000 gallons above the output for the previous year. Eighteen thousand gallons were employed in three public baths, being supplied at the rate of 30 gallons for a pool of 85,000 gallons at the first filling, and every two or three days further additions were made. For spraying the floors of schoolrooms, 1,094 gallons were used. The cost of electricity and materials for producing artificial sea water amounted to $636. Plants for producing the electrolyzed fluid are being used in Finland, Buenos Aires and Rangoon, and a large plant is being installed at Portsmouth, where actual sea water will be electrolyzed in place of the artificial fluid used at other places.

Loud-speaking Telephone for Train Dispatching.—The telephone has been displacing the telegraph on a number of roads for train dispatching, but one of the drawbacks of this method of communication has been the fact that the operator has had to wear head telephones, which are particularly annoying when there are thunder storms in the vicinity. Recently, L. B. Foley, superintendent of telegraphs of the Delaware, Lackawanna & Western Railroad, has installed loud-speaking telephones on the train-dispatching lines. The receiver, which is more sensitive than that ordinarily employed, is furnished with a horn, something like a phonograph horn, and is mounted on the dispatcher's desk at any convenient point, so that he can receive a message without putting his ear to the receiver. The transmitter is also fitted with a horn, into which the operator can speak. No amplifiers are used. With this outfit a message may be heard in all of the loud-speaking receivers on the line within fifteen feet of any one of them.

The Wind Tunnels of the National Physical Laboratory.—Owing to want of space and the enormous expense involved, experiments in the aeronautical laboratory of the National Physical Laboratory of England are necessarily confined to small scale models. Formerly, when the science of aerodynamics was still in a most rudimentary stage, this constituted a serious drawback, since the data obtained from experiments with small models at relatively slow wind velocities could not be applied with any degree of certainty to full-sized machines moving at high speeds. But, chiefly as the result of work carried out at this very laboratory, a law of dynamical similarity has now been evolved which enables model tests to be applied with a high degree of accuracy to large aeropianes. The principal part of the equipment consists of two wind-tunnels, respectively 2 feet and 4 feet in diameter, to which another and larger tunnel, measuring 7 feet in diameter, is about to be added. Accurate measurement of the wind velocity is a difficulty, but a sufficiently sensitive and accurate anemometer has now been designed consisting of a combination of a Pitot tube and a static-pressure tube. The models are suspended in the center of the tunnel, and the pressures and forces exerted upon them by the air-current measured by means of a delicate balance. So exact are the measurements thus obtained that they can be relied upon to within one half per cent.

Science

Artificially Cooled Buildings.—The authorities in charge of the construction of buildings at Delhi, the new capital of India, are investigating a plan of providing outer and inner walls, between which artificially cooled air can be circulated by means of exhaust fans, the cooling being effected by drawing currents of air through wetted screens.

An Archæological Atlas of Ohio has been published by the Ohio State Archæological and Historical Society. The author is Dr. William C. Mills, curator of the society's museum. The atlas includes county maps, showing the mounds, village sites, rock shelters and other archæological features; also maps of the early Indian trails and towns. Several photographs are included.

A Statue of the Late Edward Whymper, the celebrated mountaineer, is to be erected next year at Zermatt, Switzerland, to commemorate the fiftieth anniversary of the first ascent of the Matterhorn, July 14th, 1865. It will be recalled that this feat was attended by one of the worst disasters in the history of Alpine climbing. The descent had hardly been begun when one of the party, Mr. Hadow, lost his footing and fell to a depth of 4,000 feet, dragging three of his companions with him to destruction. Whymper and two guides were saved only by the breaking of the rope.

Thumbs of the Apes.—The gorilla and chimpanzee, which belong to the higher order of apes, have many points of resemblance to man, but there is one thing they cannot do—that is, twiddle their thumbs. In the gorilla, the thumb is short and does not reach much beyond the bottom of the first joint of the forefinger. It is very much restricted in its movements, and the animal can neither twiddle his thumbs nor turn them round so that the tips describe a circle. There are the same number of bones in the hand of the gorilla as in the hand of a man, but the thumbs of the monkey have no separate flexor or bending muscle. This is why a monkey always keeps the thumb on the same side as the fingers, and never bends it round any object that may be grasped.

Tin Disease and Polar Exploration.—Under this heading, Mr. B. T. Brooks, of the Mellon Institute of Industrial Research, contributes to *Science* a plausible suggestion to account for the mysterious loss of gasoline from tins which embarrassed the antarctic expeditions of Amundsen and Scott, and was even a principal cause of the disaster that befell the latter. It appears that at low temperatures ordinary tin is liable to be converted into the allotropic form, gray tin powder. This change takes place at a maximum rate at —48 deg. Cent. (—54.4 deg. Fahr.), and may occur more slowly at other temperatures below 18 deg. Cent. (64.4 deg. Fahr.). Hard solder, which may contain 65 per cent tin, is subject to the same process of disintegration. Hence the danger of leakage along the soldered seams of the container; a fact that should be duly considered by future polar expeditions.

The Experiment Station Record, published by the U. S. Department of Agriculture since 1889, is now in its thirtieth volume, and has gradually grown in capacity, until it now consists of twenty numbers to the year. To anyone who wishes to keep abreast of the world's progress in any department of agriculture this journal is indispensable, as it consists almost entirely of abstracts of current agricultural literature, drawn from every corner of the world and from a great number of languages. Two general indexes have been published: one for volumes 1–12, the other for volumes 13–25. Each of these is a bulky volume (the second contains 1,159 pages) and is the key that unlocks a vast library of agricultural literature. The *Record* is more comprehensive than the somewhat analogous monthly publication issued by the International Institute of Agriculture in Rome, and, in particular, covers the strictly scientific and technical literature much more fully.

Protecting the British Flora.—We have heard for some years of the efforts made by certain societies in the British Isles to preserve the flora of those islands from devastation at the hands of persons who collect flowers and plants either for their own pleasure or for sale. Recently the scope of this protective campaign has been enlarged to take account of injuries done to plants from natural or indirect artificial causes. Mr. A. R. Harwood has called attention to the far-reaching importance of these effects. Thus periods of drought cause the extermination of many plants, montane and ericetal species being especially susceptible. Bog-pools are liable to be completely dried up, with partial destruction of their flora. Drainage seriously disturbs the natural vegetation of a country. Thus the typical flora of the Fens is disappearing. Peat-cutting in Ireland has similar effects. Deforestation works striking changes in the flora. Golf-links have been detrimental to certain species of limited distribution. Mr. Harwood urges that wherever these and other similar causes are at work, efforts should be made to obtain, in the case of an association of plants, a reservation, and in that of a single station for a rare plant, some adequate means of protection.

Night Landing Signals for War Aeroplanes

Two Luminous Circles That Help Airmen to Alight in Safety

By Our Berlin Correspondent

SEARCHLIGHTS have been used successfully by aeronauts and airmen for finding their way by night or in dense fogs. A Berlin architect, Edgar Hönig, has recently patented a new type of optical signal likely to prove even more useful in this connection, which, moreover, lends itself to a multitude of other applications.

This signal comprises a system of two or more circles (or similar figures), arranged behind, inside, or below one another, vertically or horizontally, so that their centers will coincide. Their peripheries are, by night (or in case of a fog), lined with lamps of proper luminous intensity.

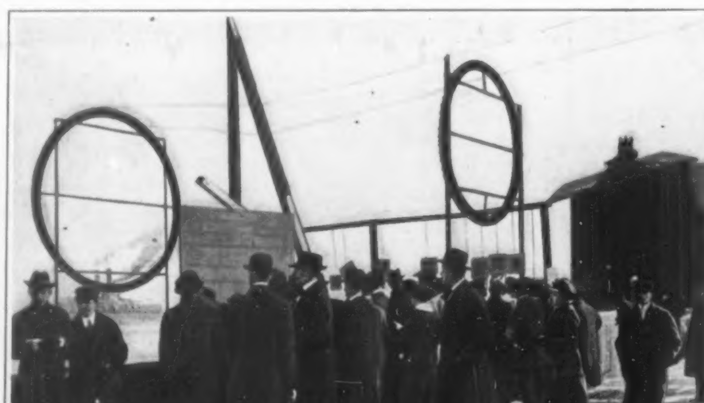
This system is of remarkable simplicity and affords a most reliable means of indicating to aircraft or vessels their position with regard to a given point (vertically and horizontally), by observing the variable perspective of the circles as seen at a variable angle. When looked at from the front, they, in fact, appear as circles, from the side as vertical, and from the top as horizontal ellipses. Their intersection affords additional hints as to their position with regard to the observer.

The arrangement so far chosen comprises two vertical glow-lamp circles of different diameters installed behind one another, on the ground, so that an airman will see two concentric circles at the moment his aeroplane is on or close to the landing ground. By a proper arrangement of the luminous circles (at right angles to the landing ground and at right angles to the landing outfit) it is thus possible to give the airman accurate signals as to the direction to be chosen and as to his distance from the ground.

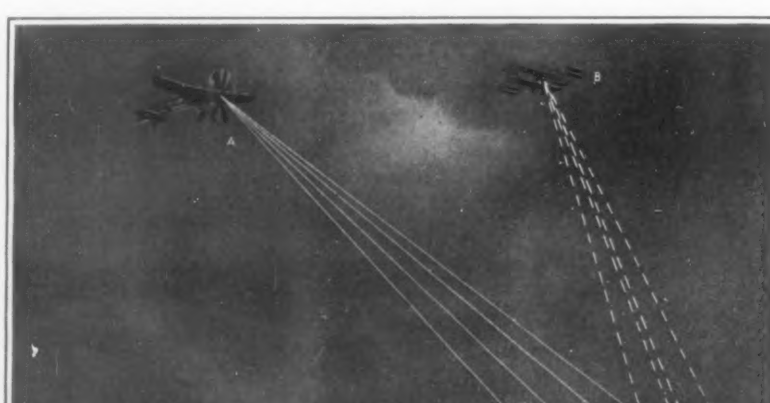
The airman, then, in landing should so control his aeroplane that the two luminous ellipses lying above one another are seen to intersect, in order afterward to soar down toward them, until the ellipses are slowly changed into circles, and, so far from cutting one another, approach the position of concentrical circles. At the moment the circles are seen apart, he knows his aeroplane to be only a few meters distant from the ground, and may commence landing operations in the direction of the optical signals.

In Fig. 1 the variable appearance of the circles is illustrated: When an observer is in position *C*, he will see two concentrical circles; in position *A*, he will see two intersecting ellipses, and in position *B*, two ellipses situated behind one another. By simply measuring the visual angle of the signal, its distance from the observer is readily gaged; for the position of the small circle with respect to the large one is a direct index of position of the aeroplane with respect to the large circle. Thus, if the small circle shows to the right of the big circle, it indicates that the aeroplane is also to the right. In the diagram, the figure at the extreme left shows how the signal would look to an aeroplane coming directly toward the landing place just before reaching the ground, the next view would indicate that the aeroplane has swung too far to the left, the third that it has swung too far to the right, while the fourth, with the circles concentric, that it has made a perfect landing. The fifth figure shows how the circles would appear after the aeroplane had risen a short distance above them.

The applications of this optical signal are many: On flying grounds, aerodromes, provisional intermediate landing grounds, it should be installed permanently. During army maneuvers and in warfare it may be readily carried by the troops, along with the tents, etc., in order at nightfall to be used for the airmen expected to arrive. It should render similar services to the navy, in connection with hydro-aeroplanes, and finally, it may prove of the greatest usefulness in navigation for signaling the entrance to a harbor, the more so as there is no risk of confusion with other lights.



Test of the two-circle landing signal.



Range signals to enable aeroplanes to make safe landings at night.

London's Water

SOME important aspects of the water supply of the metropolis were the subject of an interesting communication made at Hackney recently to the members of the Institution of Municipal and County Engineers by Mr. William B. Bryan, M. Inst. C.E., the chief engineer to the Metropolitan Water Board.

Mr. Bryan dealt first with the Lea Bridge pumping station. This plant now consists of four vertical triple-expansion engines, capable of lifting 52,000,000 gallons daily; three Cornish pumps of 29,000,000 gallons capacity; two compound rotary pumping engines, 8,000,000 gallons; one compound horizontal, 3,000,000 gallons; four turbines, 2,750,000 gallons; one triple-expansion Worthington, 10,000,000 gallons; and, in addition, two horizontal engines for pumping water from the wells to the surface of the ground.

The vastest work described by Mr. Bryan was the King George's Reservoir, which has a top water area of no less than 425½ acres, and which contains when full the enormous quantity of 3,073,000,000 gallons of water. Londoners will learn with satisfaction that this great reservoir has been practically full during the whole of the recent spring and early summer; in fact, at the present time so high is the water-level that no pumping is necessary. A brick channel takes the stored water in a southerly direction to Chingford Mill, where it joins former channels connected to the chain of reservoirs commencing near Higham Hill. All these reservoirs are filled by gravitation, with the exception of the Banbury and Lockwood reservoirs, which can only be filled to half their capacity in this manner, and water is pumped into them from a pumping station half a mile south of Chingford Mill by three vertical compound pumping engines, attached to which are centrifugal pumps, each capable of delivering 40,000,000 gallons per day into the reservoirs.

The Humphrey pumps at Chingford have created unusual interest by reason of the fact that the plant is unique in waterworks construction. There are four pumps with a capacity of 40,000,000 gallons per day each, and there is one pump of 20,000,000 gallons capacity.

Each pump may be looked upon as a gas engine and pump combined, but without piston, crosshead, connecting rod, crankshaft, flywheel, bearings, gearing, or stuffing boxes. The action of the pump can best be understood by picturing a horizontal pipe connected by two bends at its ends with a vertical closed-top combustion chamber and an open-top water tower, respectively. The parts thus connected are nearly full of water, forming a heavy mass or column, which is made to oscillate under the action of the explosion. This oscillation is quite free, and occurs in such a manner that the movement of the water causes the intake of a fresh charge of combustible mixture, the compression of the mixture, the explosion and expansion which gives the power stroke, and the exhaust of the burnt products. Thus there are four primary movements of the water during each cycle, two being from the combustion chamber toward the tower and two in the opposite direction. With each explosion of one pump twelve tons of water can be delivered into the reservoir.

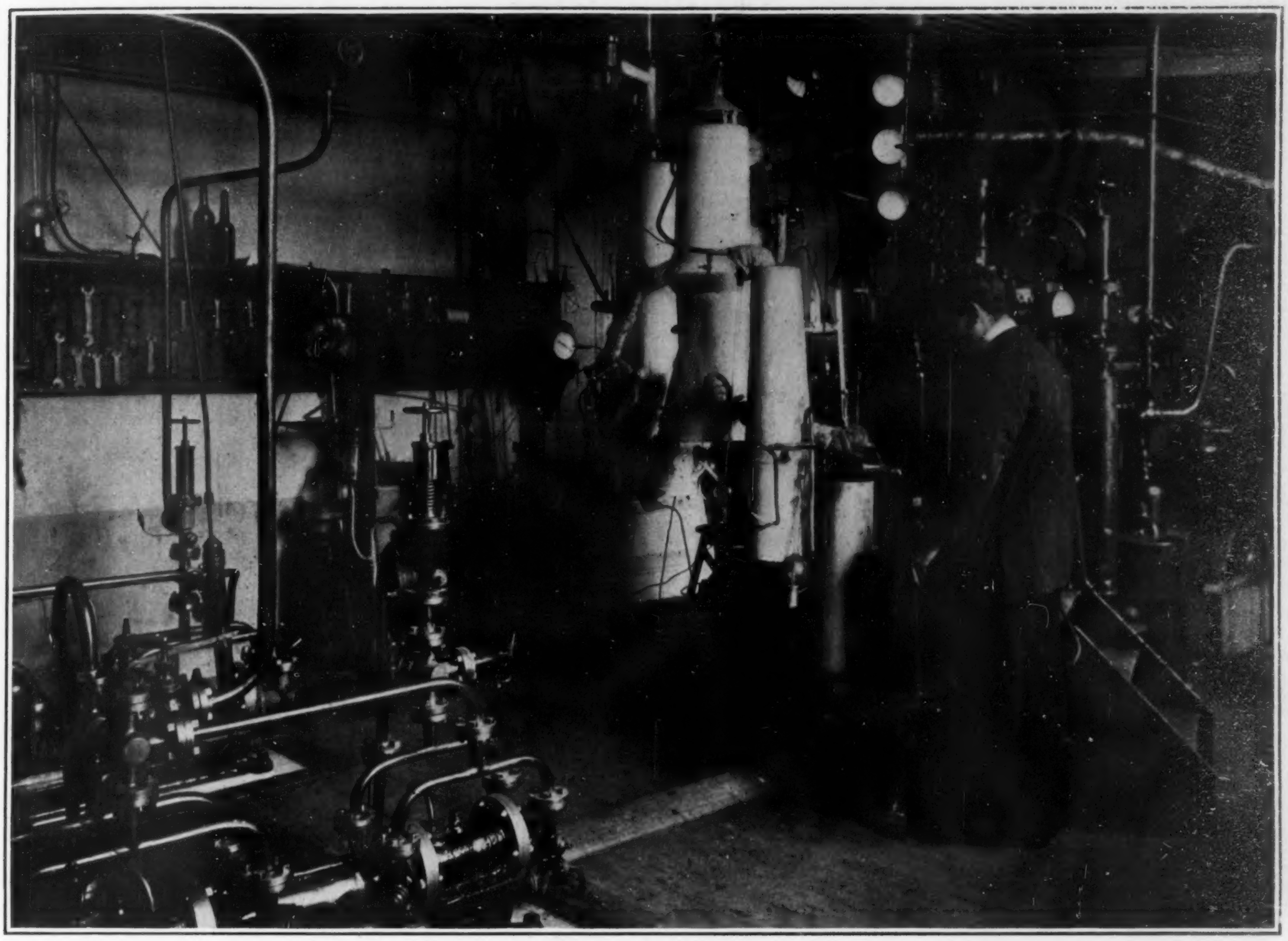
Fused Twins

THE four-legged chick, although a phenomenon known from early historical times, on its appearance in a community never fails to create a stir. Usually it receives notices in the nearby country papers, and various weird explanations are furnished.

However, embryologists now know that this peculiar monster simply represents one form of fused twin. The human race presents as many degrees of this strange tendency as are seen in any race. At one extreme is the degree of fusion seen in the Siamese twins and other examples where a pair of individuals are joined by a simple fleshy link.

The other extreme is much more common and exists where there is a duplication and multiplication of minor parts. For example, a man with a well developed extra row of teeth is an involuntary cannibal who has absorbed his twin brother. The case of the individual with a sixth finger is more puzzling. *Polydactylism*, as it is called, is known to be an inheritable character; and whether it is simply the inheritance of the tendency to imperfect twinning or something else, it is nevertheless a true Mendelian character.

A century and a quarter ago, Geoffroy St. Hilaire made a careful study of human monsters, and arranged them into several hundred species, thirty orders and a dozen classes. Nearly all of these are now recognizable as various degrees of fused twins.



Plant for liquefying methyl chloride, ethylene, oxygen, and air.

In the center, the four white apparatus are, respectively, ethylene, oxygen, and air liquefiers and the final receptacle for air.

A Permanent Electric Current Without Electromotive Force*

The Latest Discovery of Prof. Kamerlingh Onnes

WITH the help of hydrogen, which was first liquefied by Dewar, in 1898, it was possible to carry on investigations between —253 and —259 deg. Cent., these temperatures being only 20 to 14 degrees above the absolute zero; when in 1908 Prof. Kamerlingh Onnes succeeded in liquefying helium he placed at our disposal a range of temperature which is only 4.3 to 1.8 degrees above that point (—273.1 deg. Cent.) and in one experiment even reached 1.15 degrees above the absolute zero.

In experiments undertaken at temperatures produced by means of liquefied hydrogen, it appeared that various properties of matter are modified to a great extent upon approaching the absolute zero. This would lead to the inference that still greater variations in these properties should result upon cooling with liquefied helium.

For this reason, Prof. Onnes did not look upon this result as an end in itself, but rather considered it the beginning of a new period which marked the discovery of a mighty weapon which might aid him in his efforts to fathom some of Nature's secrets.

It is known that the resistance of metals is diminished with decrease in temperature. The rate for a given metal depending upon the degree of purity; i. e., the purer the metal, the greater the decrease of resistance with decreasing temperature. In the case of exceedingly pure platinum, it was found that the resistance at the lowest temperature obtainable with hydrogen is only 1/100 of the value at ordinary temperatures, while for exceedingly pure gold the ratio is only 1/300.

According to the view generally held by scientists at the present time (for which Prof. Lorentz is responsible), the electric current is a continuous movement of very small electrical particles, known as electrons. These electrons are free to move between the molecules of a conductor. If they possess sufficient velocity, they may even penetrate the molecules. If, in one way or another, these electrons are subjected to the action of a force which pushes them in a given direction, all the electrons (at least on an average) will assume a movement in that direction. If this force ceases to act, this movement will soon come to an end, and the general velocity of the electrons will be lost as a result of collisions with the molecules, or with certain parts of the molecules, at least, as a result of the influence of the molecules, of which influence, we, as yet, know very little. In order that the movement of the electrons may continue in a given direction a continuous force like an electro-motive force is required.

It would take us too far to go into a detailed explanation of the various views which have been advanced on the factor upon which the intensity of an electric current depends which is produced by a given electro-motive force in a given instance. I shall mention only two of these factors: First, the number of above-mentioned electrons which are to be found in a unit volume of the metal; second, the distance over which an electron is free to move before it will collide with, or be attacked by a molecule and retarded, after which it will be pushed forward again, but in a direction considerably different from the one in which it moved originally. It is quite evident that a given electromotive force will produce a stronger current, that is, the resistance to the passage of the current will be smaller, the greater the number of electrons present and free to move, and, also, the greater the average path of motion, that is to say, the greater the distance over which each electron is free to follow the impulse of the force.

Up to 1910, Kelvin's theory was commonly accepted that at very low temperatures, the electrons attach themselves to the molecules to a greater and greater extent, and that the electron vapor, which at normal temperatures lies between the molecules, eventually would, at very low temperatures, so to speak, condense on, or even freeze to, the molecules. This theory would lead us to believe that upon approaching the absolute zero, the resistance would not continue to fall, but would eventually increase materially.

Prof. Onnes was anxious to see if this would actually take place at the temperatures of liquefied helium. However, no evidence, or even indication, of an increase of the resistance could be established. Instead, he arrived at the conclusion that with absolutely pure platinum the resistance would be so small that it would be non-measurable and that other metals would probably act in the same way at somewhat higher or lower temperatures.

Prof. Onnes chose the metal mercury for his further researches on the lowering of resistance. Not only was his hypothesis confirmed, but to his astonishment the results obtained went even further: At the boiling point of helium, or at 4.3 degrees above the absolute zero, or at 4.3 deg. K. (Kelvin's abbreviation, this being the usual terminology) the resistance had fallen to 1/500 of the value for the resistance of solid mercury at 0 deg. Cent. (this value being obtained by calculation for degrees above the melting point). At 4.21 deg. K., the resistance became a little lower, but then came an altogether unexpected occurrence: it decreased suddenly with great rapidity, so that at 4.19 deg. K. it was too small to be measured, being less than 1/10,000,000 of the value at 0 deg. Cent.!

The apparatus for measuring resistance was made more sensitive, when it was found that at 2.45 deg. K. the resistance was, apparently, less than 1/500,000,000 of the value at 0 deg. Cent. Prof. Onnes was justified in applying the term *super-conducting* to the state of mercury at temperatures below the breaking point (4.19 deg. K.).

We have constantly spoken of resistance, but Prof. Onnes remarks that we cannot be at all sure that in the super-conducting state the same laws hold as in the ordinary conducting condition.

We have but a vague idea of the changes in a substance which give rise to the above-mentioned abnormal increase in conductivity. However, this much can be said, that the average path of motion of the electrons —second of the factors mentioned above—assumes a large value: Prof. Onnes estimates it at about 1 meter

*Neuwe Rotterdamisshe Courant. Zaturday 11 Juli, 1914. Avondblad, C.

at 2.45 deg. K. In all probability then, to a great extent, the molecules lose the power of attacking and diverting an electron from its course when the latter starts to penetrate the former.

The exceedingly high conductivity of super-conductors makes possible the transmission of strong currents through such wires. At 1.7 deg. K., it was possible to send a current of a density of almost 1,000 amperes per square millimeter through a thin mercury wire 1 meter long without a difference in potential being noticeable at the ends of the wire and without the development of heat.

However, there is a limit to the intensity of the current which cannot be surpassed at a given temperature if the current be transmitted through a mercury wire of a given diameter, if it be desired that the mercury remain a super-conductor. If the density of the wire be increased to a certain value, the so-called basic value of the density, the wire will assume its ordinary resistance. This basic value of the density is greater the further below the breaking point the value of the temperature.

It was of great importance that Prof. Onnes discovered that, upon cooling in liquefied helium, tin and lead also became super-conductors. The breaking point of tin is at 3.8 deg. K.; at 1.8 deg. K. the resistance falls to less than 6/10,000,000,000 of the value at 0 deg. Cent.; lead is a super-conductor at the boiling point of helium; and its breaking point lies at about 6 deg. K.; at 1.8 deg. K., the resistance is less than 1/20,000,000,000 of the value at 0 deg. Cent.

Prof. Onnes had a coil made from an extremely fine lead wire (diameter 1/70 millimeter), 1 centimeter long, which contained 1,000 turns per centimeter. Apparently, this coil also became a super-conductor if cooled in liquefied helium. At the boiling point of helium, a current of 0.8 ampere could be transmitted through this wire (which at normal temperatures had a resistance of more than 700 ohms) without encountering any resistance.

This is of the greatest importance for the following reasons. By using a certain mixture of iron and cobalt for the pole pieces Prof. Weiss of Zürich has succeeded in making an electro-magnet with an intensity of 55,000 gauss. Scientists, however, aim at an intensity of 100,000 gauss. It is impossible, however, to obtain such an intensity by means of an electro-magnet, the core of which produces the intensity, because the core becomes overcharged by the magnetic influence. If a current passes through the windings of a coil (without a magnetizable core) the coil itself will produce a magnetic induction. By increasing the turns per centimeter length of the coil (which also necessitates increasing the length of the coil so as to eliminate the so-called anti-magnetizing influence of the ends), and by increasing the strength of the current, it is theoretically possible to produce a magnetic intensity of any degree desired within the coil. However, the difficulty lies in removing the large amount of heat generated in overcoming the resistance of the windings. Perrin, in 1907, proposed cooling the coil with liquid air so as to take advantage of the increase in conductivity with decrease of temperature, as well as to remove the heat produced. Fabry calculated that this would require the evaporation of 1,500 liters of air per hour, and the cost would equal that of building a battleship.

It made quite a difference when it was found that lead became an exceedingly fine conductor at the temperature of liquefied helium. The heat to be removed would be 1,000,000,000 times smaller than in the case of ordinary conductors. Apparently it would be possible to obtain a magnetic intensity of the degree mentioned above with a lead coil 25 centimeters in diameter cooled in liquefied helium. According to Prof. Onnes, the cost of this would be moderate.

But it was found that the above-mentioned lead coil remains a super-conductor for small current density at the boiling point of helium as long as the magnetic intensity is less than 500 gauss. If the magnetic intensity should rise above this amount (at a low density, the basic value of the intensity at this temperature lies, for lead, between 500 and 700 gauss, at 1.8 deg. K. it is 1,000 gauss) the lead coil suddenly acquires a considerable resistance.

It is evident that a new obstacle has been placed in the path of the project for producing an electro-magnet of 100,000 gauss with the aid of a super-conductive metal. Part of the coil itself would necessarily be subjected to the action of a strong magnetic field and this part would no longer be a super-conductor, so that the advantage of cooling in liquefied helium would be to a great extent, or entirely, lost. This result was somewhat of a disappointment, but then again a new property was discovered which will help us to a better understanding of the subject.

Prof. Onnes now proceeded to the following experiment, which he had thought of previously and which clearly demonstrates the exceedingly high conductivity in the super-conducting state.

When a momentary electro-motive force acts in a circuit, a current is generated. But it is soon exhausted by the resistance of the metal. If the resistance of the metal diminishes, then the time required for the current to die out, after the electrical force has ceased to act, will increase. With ordinary conductors this time is but 1/100,000 of a second.

Prof. Onnes calculated that, with the above-mentioned lead coil, if the latter were made a super-conductor, it would take more than a day for the current to die out. The test was made as follows:

The ends of the lead wire were first fused together, so that the wire itself might form a super-conductor when plunged into liquefied helium. At the beginning of the test, the lead coil in the tube into which the liquefied helium was to be poured, was placed between the poles of a large electro-magnet. This coil was placed in such a way that the coil surface was perpendicular to the line connecting the poles. The electro-magnet was then charged and an intensity of 200 gauss produced. At this stage the lead was still an ordinary conductor and the induction current produced by this operation immediately died out again. Helium was then poured in and the temperature reduced to 1.8 deg. K. by exhausting the vapor. The magnetic field produced by the electro-magnet was then destroyed by breaking the feed current and removing the electro-magnet. This caused an induction in a direction opposite to that of the one previously mentioned. From the results obtained by Prof. Onnes in the experiments, mentioned above, he was justified in making the assumption that, under these conditions, the lead would remain a super-conductor; the magnetic intensity was less than its basic value, and, according to calculation, the current produced by induction was less than the intensity equivalent to this basic value.

The experiment fulfilled absolutely all expectations. As a matter of fact, a current did continue to run through the coil, a conclusion which was justified by the effect of the coil on a compass needle. The strength of this current was 0.4 to 0.6 ampere, a value which could be derived from the intensity of current which had to be transmitted through another coil, of proper dimensions, to counter-balance the effect on the compass needle of the current in the original coil. No decrease in strength could be observed for a full hour. If the coil were removed from the liquefied helium, and, therefore, the temperature were raised beyond the breaking point, the coil acquired an appreciable resistance, and the current died out within a short time. The experiment was repeatedly made and the results obtained were always confirmed. The fall in current amounted to only 1 per cent per hour at 2 deg. K.

To show that an electric current does circulate from the action of the lead coil on a compass needle, a galvanometer was connected in shunt with the lead coil, and after a current had been generated in the coil the lead wire was then broken between the terminals of the galvanometer, cutting out the super-conductor and making the electric current pass through the galvanometer. Immediately the latter registered, and because of the resistance in this conductor, the current was quickly exhausted and the galvanometer soon returned to zero.

It is hard to say whether in the future this discovery will be of any direct value from a technical standpoint. But there can be no doubt that it is of great value to science. And in this way it must necessarily benefit the technical world and society, indirectly, in proportion to its scientific importance, for, in this era of constant, intimate co-operation between science and technology, every increase in our scientific knowledge of phenomena has a marked influence on industrial and technical applications.

The Current Supplement

INVESTIGATIONS at the Cryogenic Laboratory at Leyden is the leading article in the current issue of the Scientific American Supplement, No. 2017, and gives an interesting insight into the remarkable investigations made by Prof. Kamerlingh Onnes in the regions of extreme cold, a degree of cold in which hydrogen and helium are liquefied; and another article, by Prof. Onnes himself, gives the first account of a remarkable discovery in relation to the action of electricity in extremely low temperatures, "endless electricity" it has been termed.—The instructive article on coal and its by-products is concluded.—There is another installment of the article on the flying machine, by Mr. Lanchester, which is of value to every engineer. Aerial reconnaissance discusses a new use for the aeroplane.—Prof. Hugo de Vries of the University of Amsterdam discusses the principles and theory of mutation.—There is a paper on producer gas in a manufacturing establishment.—Linking India and Ceylon by railway tells of railway development in the Far East, and another articles describes an English airship of improved design.

A Century of Dreadnoughts

By Percival A. Hislam

ON December 1st last there was launched at the yard of the Mitsu Bishi Company, Nagasaki, the Japanese cruiser "Kirishima," and to this ship—destined to steam 27 knots and to carry eight 14-inch and sixteen 6-inch guns on a displacement of 27,500 tons—belongs the distinction of being the hundredth ship of the dreadnought type to go afloat. The pioneer ship of the type, the British 17,900-ton battleship "Dreadnought," was launched on February 10th, 1906, so that the "all-big-gun" ship has been a little under eight years reaching its "century." The rate of increment so far as the principal Powers are concerned has been as follows:

Launched in	'06	'07	'08	'09	'10	'11	'12	'13	Total
Britain	1	6	2	3	4	8	5	4	33
Germany	..	..	4	4	2	4	3	5	22
United States	..	..	3	2	1	2	2	..	10
France	..	..	..	..	..	2	2	3	7
Italy	..	..	..	..	1	3	..	2	6
Japan	..	..	..	..	1	1	2	1	5
Russia	..	..	..	..	..	4	..	1	5
Austria	..	..	..	..	..	1	2	..	3
Brazil	..	..	1	1	..	..	..	1	3

In this table the number of ships accounted for is ninety-four. The balance is made up by two ships launched for the Argentine Republic in 1911, two launched for Spain in 1912 and 1913, respectively, and one launched for Chili and one for Turkey in 1913. It will be noticed that Brazil is credited with three ships in the table. The third vessel, the "Rio de Janeiro," is, however, in the market at the moment of writing, and there is keen competition between Austria and Greece for the possession of the ship, which has the unique main armament of fourteen 12-inch guns in seven center-line turrets.

Great Britain naturally takes the lead as a dreadnought power, but it will be seen that her superiority over her nearest competitor is only 50 per cent, and, further, that she has only launched twenty-six dreadnoughts, while Germany has launched twenty-two. These two powers account for fifty-five ships of the type, leaving forty-five to be distributed among the remaining eleven nations which have so far launched a ship of this class. Europe is divided politically into two great camps, the Triple Entente (Britain, France, and Russia) and the Triple Alliance (Germany, Italy, and Austria). The former have forty-five and the latter thirty-one dreadnoughts afloat—a total of seventy-six; so that only twenty-four ships remain after deducting those that contribute toward making Europe the armed camp that it is. America claims sixteen ships—ten in the North and six in the South—and the balance is made up by the Japanese quintette and the three ships which Spain and Turkey divide between them. There is a striking moral for Americans in the fact that while the United States Navy is less than half as strong in dreadnoughts as the German, the position in 1908, when both nations launched their first dreadnoughts, was that the United States had thirty-four completed armored ships not over ten years launched to Germany's twenty-five.

The idea seems to be gaining ground that there is a tendency to reduce the size of battleships, or at any rate to put a decided check upon the rate of increase in displacement. Taking the eight principal powers, there were thirteen battleships launched in 1905—the year before the first dreadnought went afloat—and they averaged in displacement 14,462 tons. In subsequent years the figures, as regards dreadnoughts, have been as follows, it being pointed out that for some of the latest ships the displacements are not absolutely official:

DREADNOUGHT LAUNCHES.

Year.	Ships.	Total Tons.	Average Tons.
1906	1	17,900	17,900
1907	6	107,550	17,925
1908	10	184,150	18,415
1909	10	205,395	20,539
1910	9	195,955	21,773
1911	27	627,320	23,234
1912	17	406,900	23,935
1913	20	499,096	24,955

It will be seen that the period of greatest increase was between 1908 and 1911, which is just the period when competition in this class of ship began to manifest itself. As regards present tendencies, those who foretell the gradual reduction of battleship displacements base their arguments mainly upon the fact that while the ships laid down under the British programme for 1912 ("Queen Elizabeth" class) will be of 27,500 tons, those of the 1913 programme ("Royal Sovereign" class) will be some 2,000 tons smaller. They altogether ignore the fact that while the "Queen Elizabeths" are to steam 25 knots, the later batch will steam no more than 21 or 22; and the addition of three or four knots after the twenties have been entered makes a vast demand upon tonnage. The "Queen Elizabeths" have the advantage of oil fuel, while their successors are to burn coal; but this cannot, after all, have made a great deal of dif-

ference in comparison with the demands of speed, because, if report speaks correctly, the "Royal Sovereigns" are to have two more 15-inch guns, ten as against eight.

There is the further fact to be considered that as there are bigger fish in the sea—or so it is said—than ever came out of it, so there are bigger ships on the stocks than any yet afloat. The heaviest ships yet launched are the German battle-cruisers "Derfflinger" and "Lutzow" and the Chilian battleship "Almirante Latorre," all of 28,000 tons. Compare this with the tonnage of certain ships now building. The four battleships of the new Italian programme—virtually reproductions of the British "Queen Elizabeth" design—will displace 29,510 tons apiece. In Japan there are under construction the "Fuso" and three sister battleships, all of 30,000 tons displacement, designed to carry twelve 14-inch guns and to steam 22.5 knots. The United States ship "Pennsylvania" and her successor will displace 31,400 tons apiece; while there are even heavier vessels at this moment in hand—the Russian battle-cruisers "Kinburn," "Ismail," "Borodino," and "Navarin," which, carrying nine 14-inch and twenty 4.7-inch guns and steaming 26.5 knots, will displace 32,200 tons. Battleships may or may not decline in dimensions in the near future; but, at any rate, there is no concrete evidence of any such development.

It is said that torpedo attack from submarines is the factor which has doomed the heavy battleship, and that this class of warship will be reduced in size in order to minimize the area of the target offered. The same argument might have been advanced at any stage of naval development; but the line of advance followed by every naval power has, in recent years at all events, been this: that the best defense against guns is to smash them before they can harm you, and that the best defense against underwater attack is a hull of such size and strength that a torpedo or two can make but little impression on the structure as a whole. Tonnage means strength; and although it also means ability to be hit, the former increases at a far greater rate than the latter. Let the comparison between the "Florida" and the "Pennsylvania" speak for itself:

	Florida.	Pennsylvania.	Pennsylvania Greater by
Target:			
Length, ft.	510	600	17.6 per cent
Draught, ft.	28½	28 ft. 10 in.	1.2 " "
Defense:			
Main belt	11 in.	14 in.	27.3 " "
Tonnage	21,825	31,400	43.9 " "
Offense:			
No. of guns	10	12	20.0 " "
Broadside	8,700 lb.	16,800 lb.	93.1 " "

In face of such facts as these, can it be doubted which is the better investment? Battleships increase in size because they can give more and stand more knocking about for every additional ton of displacement.

How Much It Costs to Kill a Man in Battle

IN *La Science et la Vie*, Gen. Percin of the French army states that he read in an American newspaper that to kill a man in modern warfare costs in the neighborhood of $15,000. "This figure seeming to me to be excessive," he says, "I sought to verify it. My results show that really the newspaper was below rather than above the truth. To get at the cost of killing one soldier it is necessary to divide the cost of the war to one of the belligerents by the number of men killed on the other side.

"In 1870-71 France spent about two billions of francs in the actual warfare and a billion more in restoring its own property and in payments for injuries caused to others, which it is perfectly fair to include in the costs. Then there were five billions for war indemnity and still two billions more for interest, loss of revenue and seizures by the enemy for maintenance during the German occupation. The last may or may not be a cost in a given war, so that it had better be left out of the reckoning. In the same way the Russo-Turkish war of 1877-78 cost two billion francs to the Turks, and the Russo-Japanese war, 1905, cost the Russians six billions. In the Franco-Prussian war there were 28,600 Germans killed or mortally wounded; in the Russo-Turkish war, 16,600, and in the Russo-Japanese, 58,600, in the latter instances, of Russians and Japanese, respectively. From these figures it is evident that the price per man killed to the opposing side was, in 1870-71, $21,000; 1877-78, $15,000, and in 1905, $20,400, all of the figures in excess of those named in the American journal.

"I rather expected when I undertook this calculation to find that the costs were increasing. On the one side the engines of war cost more as they are perfected. On the other hand, progress in the art of killing is always surpassed by progress in the art of defense. The result is that the ratio of men killed or wounded in actual battle is continually diminishing. This ratio was 6 per cent under Frederick the Great, 3 per cent under Napoleon, 2 per cent in 1870, and ½ per cent in Manchuria. But in 1870 there were not a dozen great battles. The German armies fought little between Fröschwiller and Sedan and the French little between Sedan and Coulmiers. The fight was taken up again in December, but less sharply than at the beginning. During much of the time men did not kill, but the expenses never ceased. In Manchuria, on the contrary, they fought nearly every day. The battles were long ones, fifteen days at Mukden, twelve at Cha-Ho, and eight at Liao-Yang. This increase in duration of the battles compensates for the slight loss in any individual hour of the fight. One may see also why the cost of a man killed is not higher in 1905 than in 1870.

"It will be impossible to predict with exactness how much it will cost per man killed in the next war; the sum will depend upon the nature of the struggle. If fighting continues nearly every day, as in Manchuria or in the Balkans, the cost will be approximately the American estimate. If the battles are as in 1870, at rare intervals, the cost will increase in very appreciable ratio. It will not diminish, that is certain.

"That which kills and reduces efficiency in war is not the cannon or the rifle, but fatigue, cholera, and typhoid. In 1870 there were registered in the hospitals no less than 380,000 Germans, who, although they survived, were inactive for some time. The Crimean war cost the Allies four times as many deaths from sickness as from battle. This ratio was three to one among the Russians in 1877-78 and only two to one among the Japanese, thanks to their excellent hygiene. I count more, therefore, on improved hygienic methods and the art of avoiding losses in war than on progress of ballistics and of the means of destruction."

Adolf Martens

BY the death of Adolf Martens the engineering world has lost an imposing figure, and one of unusual ability and force of character. Born in Backendorf in the year 1850, he received his early education in Schwerin and Carlottenburg, and later received the honorary degree of Doctor of Engineering at Dresden. During a long career of usefulness, Martens gave his special attention to investigations in relation to the various materials employed by engineers, in which direction he appears to have been possessed of unusually keen and discriminating powers. His work was held in high esteem by engineers in all parts of the world; and it was greatly regretted when, in later years, he was obliged to give up his work of investigation to assume an administrative office as director of the Royal Material Testing Office, which consumed his entire time.

Adolf Martens is best known through his work on "Testing Materials," which has been translated from the original German into English, French, and Russian; besides which he has been a frequent and valued contributor to various technical and scientific publications. He was a lecturer at the Charlottenburg Technical School and a member of the Berlin Academy of Sciences, as well as of many other technical societies.

Besides his notable distinctions in the scientific world, Martens attained high honors in the social life of his country, and at the time of his death held the title of Geheimer Oberregierungsrat. He had also received the decorations of the Red Eagle IV and the Prussian Crown III, besides other honorary decorations from Holland, Norway, Sweden, and Denmark. He was president of the German Congress for Testing Technical Materials and vice-president of the International Congress. Though of a strong and even dominating personality, Martens possessed a warm-hearted democracy that endeared him to all who enjoyed his personal acquaintance.

Towing Artillery by Motor Car

IT is said that artillery is the most potent factor in winning battles, and in view of this fact a recent experiment made in England is of interest. A horse battery weighing thirty-three hundredweight was attached behind a motor car, towed seventy-five miles and made ready for action in less than five hours, a feat that would have required thirteen or fourteen hours if rail transportation had been depended upon. Besides the towing ability of the automobile, the questions of braking on steep hills and whether the gun mounting and wheels as at present constructed would stand the strain, were involved, and these appear to have been satisfactorily answered. As a result of the experiment it is suggested that automobile manufacturers be subsidized by the government to keep always available a certain number of suitable chasses for gun transportation, which would undoubtedly have the effect that no successful hostile raids would be possible. The result of this experiment, if adopted, means that at short notice such an enormous superiority in artillery could be concentrated at any given point on the coast as to make it almost out of the question for a raiding force to move from under the shelter of the guns of its escorting warships, supposing them still to be present; and as the whole object of a raid—which is quite a different thing from invasion in force—is speed in arriving at its objective before sufficient force can be concentrated to deal with the raiders, it is obvious that the game ceases to be worth the candle.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

How to Secure the Promotion of the Most Efficient Naval Officers

To the Editor of the SCIENTIFIC AMERICAN:

Permit me to set down very briefly an alternative plan for the promotion of officers, a plan which I think is superior to that recently advocated by you.

Certainly the highest ranks should be held by selected officers. Accurate selection can be made only by officers themselves from among themselves. As a rule, admitting exceptions, officers know thoroughly only their neighbors on the list, those about two years on each side, some younger and some older. Age, health and physical vigor, character, intellectuality, temperament, and, above all, character, must be the determining qualifications. It is so desirable as to be deemed essential that, in the flag ranks, officers should have at least a minimum of five, six, or seven years to serve before arriving at retiring age; and that can never be if we adhere to strict seniority promotion. (I confine attention just now to flag rank only, simply for brevity in explaining the plan that I shall propose to you.)

Suppose that next year there are to be five promotions to flag grade. Very well; let those five be chosen by the senior twenty captains from among themselves, and let the remaining fifteen, as a result of their own action, pass to the retired list, with the rank, but not the pay, of rear admirals. I say "with the rank" because I think that just recognition should be made of the value of the service performed by them in doing what they alone could have done so well, namely, choosing the best for advancement. And "but not the pay," because any pecuniary reward would somehow tarnish their action.

Now just consider some of the effects of the plan as thus proposed. The very best selections will be made. The officers advanced would get their higher rank with a great addition of honor and a deep feeling of grateful pride and solemn responsibility. The officers retired by their own act would, so it seems to me, leave the active service with no feeling of humiliation or heart-burning; glad to have been able to lift young and competent men to high place. "In honor preferring one another" is no light or idle phrase.

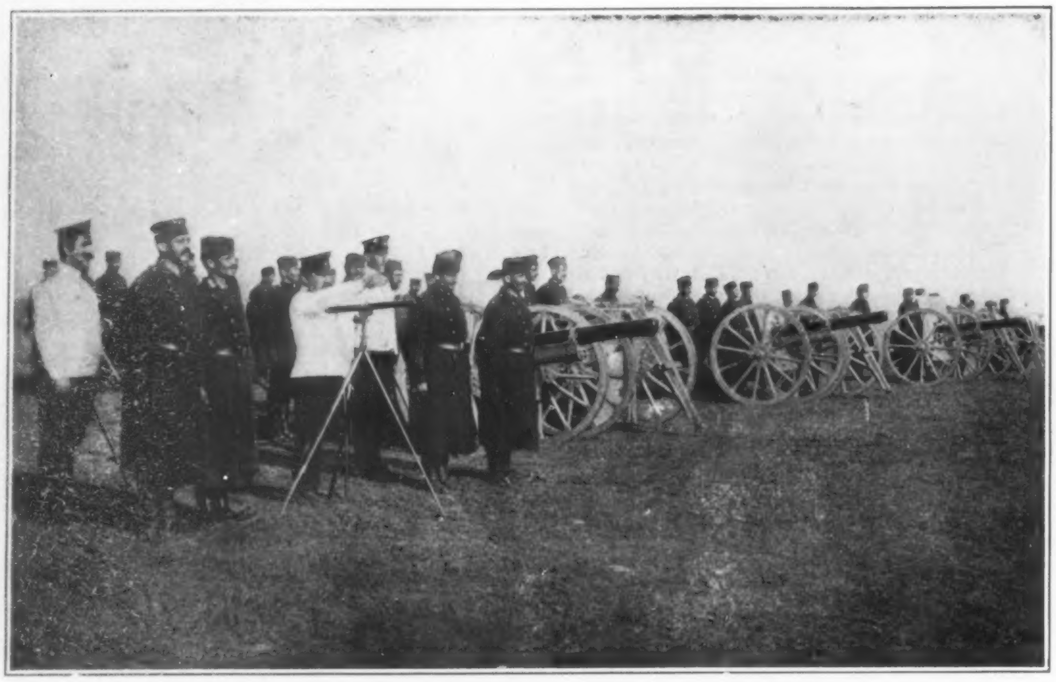
I know that the present plucking system has a very depressing effect far down the line, tending to diminish the attraction of the service, while death itself would be preferable to the officer plucked.

So admirably do they illustrate the principle of selection as described above that I venture to quote some of the regulations concerning the bestowal of the Victoria Cross:

" . . . It is ordained that, in the event of a gallant and daring act having been performed by a squadron, ship's company, a detached body of seamen and marines not under fifty in number, or by a brigade, regiment, troop, or company, in which the admiral, general, or other officer commanding such forces may deem that all are equally brave and distinguished, and that no special selection can be made by them; then, in such case the admiral, general, or other officer commanding, may direct that for any such body of seamen or marines, or for every troop or company of soldiers, one officer shall be selected by the officers engaged for the decoration, and in like manner one petty officer or non-commissioned officer shall be selected by the petty officers and non-commissioned officers engaged; and two seamen or private soldiers or marines shall be selected by the seamen, or private soldiers, or marines engaged respectively, for the decoration; and the names of those selected shall be transmitted by the senior officer in command of the naval force, brigade, regiment, troop, or company to the admiral or general officer commanding, who shall in due manner confer the decoration as if the acts were done under his own eye."

Washington, D. C. EFFICIENCY.

The Fertilizing Qualities of Tropical Rainfall are probably not realized by most students of agriculture. Nitric acid is formed in the atmosphere by lightning discharges and is most abundant in regions where thunderstorms are of frequent occurrence. In the *Annales de Géographie* M. Guillaume Capus discusses the results of chemical analyses of rain-water made in French Indo-China, and bases thereon an estimate of the total value of the fertilizing substances brought to the soil by rain over a great rice-growing region. In the thirteen provinces constituting the Tonkin delta he estimates that the amount of atmospheric nitrogen thus annually obtained is equivalent to 181,390 tons of nitrate of soda, and 137,510 tons of sulphate of ammonia, worth $19,822,000.

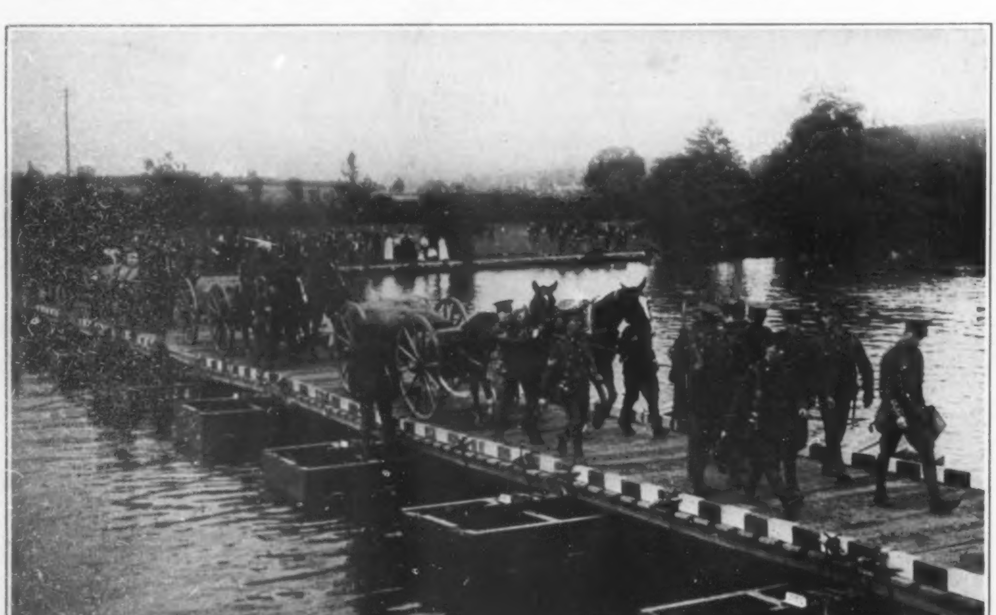


Servian field artillery.

How the light French machine guns of a

Count von Moltke; the German Emperor; Count von Zeppelin; Excellenz von Scholl.

A French military wireless station.



An English pontoon bridge for the crossing of streams.

A German covered battery and mas

THE EUROPEAN ARMIES

e gns of a mountain battery are transported.

German infantry firing from trenches.

Traveling kitchen of the 131st French infantry.

German infantry on the march.

ery and masked observing position.

A new form of field oven used by the British. The meal is cooked by the time camp is reached.

AN ARMIES IN ACTION

The Heavens in September

New Information About the Brilliant and Massive Stars of Scorpio

By Henry Norris Russell, Ph.D.

BEFORE the brilliant summer constellations disappear on the southwestern horizon, we may look with especial interest upon Scorpio, in the light of an admirable investigation by Prof. Kapteyn, which has just appeared. This distinguished astronomer has been engaged for a long time in a thorough study of the motions of the stars, and has of late been devoting special attention to that remarkable class which show in their spectra the dark lines of helium. These stars are the whitest of all in the heavens, and probably the hottest; they are of enormous real brightness, and are remarkable, too, because they are moving much more slowly in space than are most of the other stars, so that the greater part of their apparent motion in the skies arises from the Sun's own motion past them through space.

It has been known for some time that a number of these stars, especially those in Scorpio and the neighboring constellation Centaurus, were apparently moving in almost parallel directions, and probably formed a group, in motion together through space. A diagram showing this motion was printed in these columns some time ago, and is here reproduced.

Prof. Kapteyn, who was one of the first, if not the first, of all to recognize this fact, has made an exhaustive study of the motions of the "helium stars" in this and other regions of the sky, and has obtained conclusive evidence that almost the whole of the stars of this type in a huge region of the sky, 60 degrees wide and 140 degrees long, extending for 30 degrees on each side of the Milky Way from Argo past the Southern Cross and Centaurus to Scorpio and Ophiuchus, are moving together, relatively to the Sun, at least. If allowance is made for the Sun's motion, they must be almost at rest relative to the general average of the stars; but as seen from our own moving system, they all appear to be drifting toward the same point in the heavens, which lies about 5 degrees northwest of the bright star Vega. The apparent rate of motion is usually very low, averaging not more than 4 seconds per century, or 1 degree in 90,000 years; but the accurate computations contained in Prof. Boss's great catalogue determine even these small motions with very considerable precision.

Spectroscopic measures of radial velocity, which have been made for many of these stars, show that the actual rate of their motion is fairly rapid—18 kilometers, or 11½ miles, per second.* When this has been determined, the actual distance of each individual star which belongs to the group can be computed by simple formulæ. In this way Prof. Kapteyn has succeeded in determining the actual distances of 236 of these stars. Owing to the small errors of observation, and the fact that the stars, though moving very nearly in parallel lines and at the same rate, are not exactly doing so, the deduced distances may be, on the average, as much as 25 per cent in error; but this is very satisfactory, for there are not very many, even of the nearer stars, whose distances are known more precisely than this, and the stars here considered are so far off that there is no other way of finding their distances, even roughly. Only one of the lot is within 100 light-years of the Sun. The majority lie between 180 and 400 light-years; but some are probably as much as 1,000 light-years away, and even more.

All the brighter stars but one in the northern part of Scorpio belong to this great group, the exception, ϵ Scorpii, being a star of large proper-motion which is presumably very much nearer us than the others. The conspicuously red Antares, though quite unlike the others in spectrum, agrees with them so closely in the amount and direction of its motion that there can be no doubt it belongs to the group.

The distances and real brightness of the fifteen brightest stars of the group in this region are given in the table herewith, arranged in order of their apparent brightness. All these stars are marked on the accompanying map of the heavens except ω_1 Scorpii, which is the uppermost of a pair of faint stars just below β. μ Scorpii is a fine naked-eye double—not easily seen in our latitudes, because it is so near the horizon, and both its components belong to the group.

The most remarkable thing about these stars is their enormous luminosity. The faintest of them, which are not very conspicuous to the unaided eye, send out two or three hundred times as much light as the Sun, while Antares is the brightest object that is so far definitely known, though Prof. Kapteyn finds that β Centauri is almost equal to it (some 3,000 times as bright as the Sun). It is not improbable that some of the stars whose distances cannot yet be estimated, like Regel and Canopus, are even brighter.

It is a very natural thing to ask, Why should these

Proper motions of stars in Scorpius and Sagittarius in one hundred thousand years.

stars be so exceedingly bright? Several causes probably combine to bring this about. In the first place, these stars are unusually massive. Several of them are spectroscopic binaries, and their masses can be determined, though observations have so far been completed only upon two. The combined mass of the pair of stars which form β Scorpii is many times greater than that of the Sun, while in the case of μ Scorpii it is also very much larger. But this alone will not account for their brightness. A pair of stars, each of ten times the Sun's mass, but similar to the Sun in density and giving out the same amount of light per square mile as the Sun does, would together emit only nine times the Sun's light, which is far too small an amount. But judging from the analogy of other stars of similar spectrum, we may expect such pronounced helium stars as those which we are considering (except Antares) to be of less than one tenth the Sun's density, perhaps as little as one fiftieth. A pair of stars of density between these limits, and each of ten times the Sun's mass, would have a combined surface area somewhere between 40 and 125 times that of the Sun. To send out as much light as the brighter stars in Scorpio do, they would have, even so, to emit more than ten times

Star.		Magnitude.	Distance, Light Years.	Real Brightness, the Sun's light being 1.
α	Scorpii (Antares)...	1.2	380	3400
λ	"	1.7	365	1900
κ	"	2.5	510	1900
δ	"	2.5	305	670
υ	"	2.8	310	550
β	"	2.9	385	690
τ	"	2.9	330	550
π	"	3.0	330	500
σ	"	3.1	380	610
μ_1	"	3.1	440	800
μ_2	"	3.6	400	420
ρ	"	4.0	410	310
ω_1	"	4.1	385	240
ζ	"	4.3	370	200
θ	Ophiuchi............	3.4	420	600

as much light per square mile as the Sun does. But this is quite reasonable to believe; in fact, the best available estimates of their temperature lead to the belief that their surface brightness must be about twenty times the Sun's.

It seems therefore very probable that the great luminosity of these stars arises from the co-operating influences of great mass, low density, and high temperature. If, among the numerous spectroscopic binaries of this group, some are found to be eclipsing pairs, as is very probable, the exact contributions arising from each of these three factors can be determined, and we will know more about these stars than any others.

The above remarks do not apply to Antares, which is a fiery red star, and, by all the signs, must be much colder than the Sun, and give out less light per square mile. All the evidence indicates that it would be a high estimate to assume that the surface-brightness of such a star was one tenth that of the Sun. If this is the case, Antares must have some 34,000 times the Sun's superficial area, which would make it more than 180 times as big as the Sun, or 160 million miles in diameter, and nearly as big as the whole orbit of the Earth. This is a remarkable conclusion, but appears to be clearly indicated by the facts. There is good reason to suppose that the mass of Antares is not correspondingly great; in fact, not much, if at all, greater than that of the other stars in Scorpio; so that the density of this great red star is in all probability excessively low.

At 11 o'clock: Aug. 7.
At 10½ o'clock: Aug. 14.
At 10 o'clock: Aug. 22.

At 9 o'clock: Sept. 6.
At 8½ o'clock: Sept. 14.
At 8 o'clock: Sept. 21.

At 9½ o'clock: August 29.

NIGHT SKY: AUGUST AND SEPTEMBER

The Heavens.

Our map has been chosen to show the early evening skies, in order to exhibit the whole of Scorpio, which is just sinking in the southwest. East of it is Sagittarius, and then Capricornus, now brightened by the presence of Jupiter. Then comes Aquarius, a very dull constellation, and below this the Southern Fish, with its one bright star, Fomalhaut. The great square of Pegasus is well up in the east, and Andromeda and Perseus are in the northeast. Cassiopeia and Cepheus are above the latter; then comes Cygnus, right overhead, and Lyra and Aquila to the west and south. Ophiuchus and Serpens are in the southwest, and Hercules, Corona, and Boötes in the west. The Great Bear is low on the horizon, just west of north, and the Little Bear and the Dragon are above it.

The Planets.

Mercury is an evening star all through September, but is poorly placed for observation, being south of the Sun and at a rather small elongation, and can only be seen just after sunset at the end of the month. Venus is evening star, and is at her greatest elongation, 46 degrees 27 minutes east of the Sun, on the 18th; but she, too, is far south, and so is less conspicuous than usual, setting between 7:30 and 8 P. M.

Mars is evening star, too, but is farther west than Venus, and sets earlier—about 7:10 P. M.—in the middle of the month, so that he has become practically invisible.

Jupiter is in Capricornus,* just past opposition, and well placed in the evening sky, of which he is the most conspicuous ornament.

Saturn is coming out into the morning sky. He is in

(*Concluded on page 154.*)

Remarkable Wood Preservation

By S. F. Maxwell

THERE is at La Brae, near Los Angeles, Cal., a spot of extraordinary scientific value. It is an asphalt deposit from which bones of prehistoric animals have been taken by the ton, among them the skeleton of a man supposed to be 200,000 years old. The asphalt pit was apparently once a fissure filled with viscid oil or magma. Animals that ventured upon it sank and perished. The place is full of bones, skeletons of camels, sloths, tigers, wolves, bisons. It is believed that most of these animals belonged in the Pleistocene period, immediately preceding the modern, and that they lived some 200,000 years ago.

A log of wood with bark still on it was found standing upright among the bones. How it happened to reach that place and attain that posture is a matter for speculation. The bark is rough and stringy, but falls to shreds when the asphalt is dissolved out with gasoline. The wood is quite dark. The color does not seem to be due to the asphalt, because when a gramme of chips is soaked in a few cubic centimeters of gasoline for a day or so, little color is imparted to the liquid. Neither does the wood respond to tests for tannin. Although brittle and hard to cut in thin cross-sections, the wood does not differ materially in hardness from other soft woods.

The tree was of very slow growth. Each annual ring is about three tenths of a millimeter broad, and there are from eleven to fifteen rows of wood cells to the ring. The resin ducts may be plainly seen with globules of resin in them. The state of the wood's preservation is wonderful. The delicate cells, even down to their bordered pits and tori, are all in place and unbroken, though apparently slightly compressed. Under the microscope the wood looks as fresh as a sample newly cut from a living tree, except that the grains of starch or other substance in the medullary rays are slightly shriveled, and threads of fungus are visible. The wood appears to be one of the junipers.

The tree was evidently dead before it went into the asphalt. The presence of the fungus is the proof of this. There are many fine threads, or mycelia, not more than twelve ten-thousandths of a millimeter in diameter, ramifying through the wood, lengthwise with the wood cells and also penetrating their lateral walls. Some of these threads are a centimeter long. The position of the fungus indicates that its activities were suddenly ended. That doubtless occurred when air was excluded by the log's immersion in the plastic asphalt. Everything remains as it was at the last minute. Many of the mycelium tips appear just in the act of piercing a cell wall. Here and there are branches just budding from a main thread. It reminds one of the fate of Pompeii—the suddenness with which life was blotted out. Substitute a colony of fungus in a log of wood for a city full of men; a pool of oil for hot ashes; and the similitude is complete.

Oil is evidently an excellent preservative. During two thousand centuries that tree lay buried in asphalt, and it comes out as well preserved as it was the day it went in. The wood's examination was made with a power of 300 diameters on an ordinary microscope. The wood sections were cut from points within two centimeters of the bark.

A Double-piston Internal-combustion Engine

THE idea of the double-piston engine is not new. It dates back to Bodmer, who in 1834 invented a steam engine with two pistons that operated toward and from each other in a single cylinder. The principal drawback to this construction was found to lie in the stuffing boxes. However, this drawback does not apply to the single-acting internal-combustion engine, and we find in the accompanying illustration an engine of this type with two cylinders, each fitted with double pistons. The advantages claimed for this novel engine are that it obviates certain difficulties of heat radiation common to the ordinary internal combustion engine, that the weight per horse-power is decreased, and that it does away with useless forces and negative work.

For the purposes of identification we have lettered the pistons, in the nearer cylinder *A* and *B*, respectively, and the pistons in the farther cylinder *C* and *D*. The piston *A* is fitted with a crosshead from which a pair of rods run down obliquely to a pair of crossheads carried by the piston *D*. In like manner pistons *B* and *C* are connected by a pair of oblique rods. The engine is of the two-cycle type. In the position illustrated the explosive mixture is entering the farther cylinder through an intake port that has just been uncovered by the piston *C* and is displacing the products of combustion which pour out of the exhaust port that has been uncovered by the piston *D*. In the meantime the charge in the adjoining cylinder has been compressed, and on ignition it will force the pistons *A* and *B* apart. The piston *B* acts directly on the crank-shaft, while the piston *A* also acts on the crank-shaft, but through its connection with piston *D*. As the pistons *A* and *B* move apart, the pistons *C* and *D* are pulled together by the rod connections, compressing the charge between them.

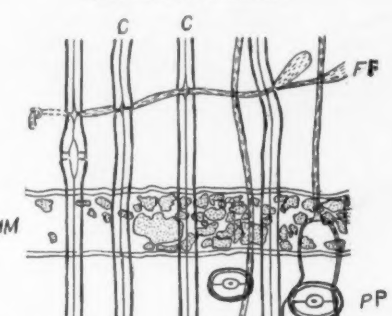
The chief mechanical drawback to this construction lies in the obliquity of the connecting rods which produces a horizontal thrust on the crosshead slides. However, the thrust of the two sets of rods is equal and opposite, preserving a balance that prevents vibration. One of the principal mechanical advantages of the construction lies in the fact that the work of compressing the charge is not performed through the crank and connecting rod, but directly through the oblique rods, and only useful work is transmitted to the crankshaft. The center of gravity of pistons *A* and *D* travels vertically in the plane *Q P*, while the center of gravity of the other pair travels in identically the same plane, but in the opposite direction, so that the two motions are perfectly balanced.

The advantages of this engine from the point of view of heat are quite obvious. The cylinders consist of two water-jacketed tubes open at each end. As there are no cylinder heads, each tube is free to expand symmetrically, and as there are no corners or pockets, the mean temperature of the inner surface of the cylinders is very low.

In a new construction of this engine, wherein eight two-stroke pistons are combined with four cranks, the weight for a given power is from one half to one third of that required in other constructions. A 500 horsepower engine of this type was recently put to a test. It weighed without flywheel under 20 tons, and gave some 550 horse-power continuously. An ordinary gas engine of equal power would weigh twice as much. This result was obtained with four cylinders, 12 inches in diameter, at a moderate piston speed of 750 feet per minute, and a low mean effective pressure of under 70 pounds per square inch. Despite the makeshift character of the auxiliaries for supplying the engine with air and gas, it showed an overall efficiency during a 30-hour test of just under 30 per cent, while the indicated efficiency was 37.6 per cent. The mechanical efficiency of the engine itself was about 90 per cent.

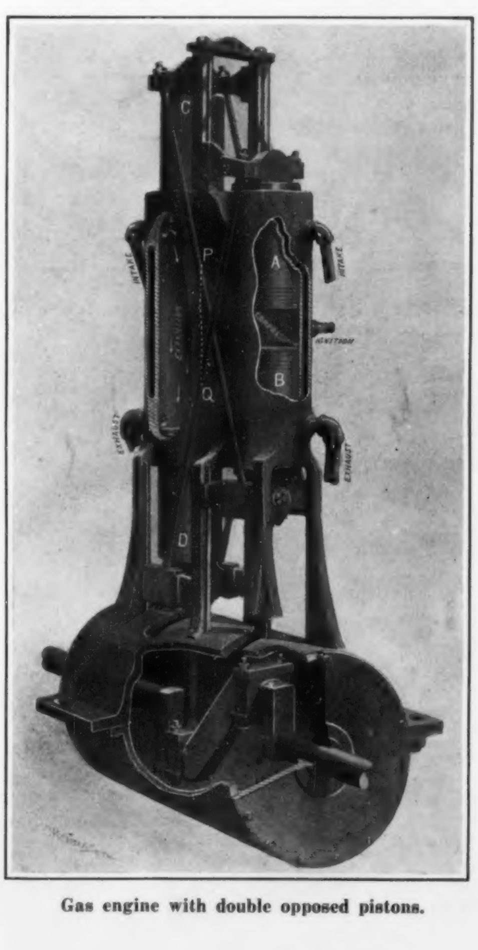
Longitudinal section of La Brae wood, showing cells, pits, fungus, medullary rays, resin duct, etc.

Made with 300 diameters.



Longitudinal section, showing four cell walls, a medullary ray, fungus threads, and pits.

C, Cell walls; *F*, fungus threads; *M*, medullary ray; *P*, pits.



Gas engine with double opposed pistons.

Welding Malleable Castings

WHILE the process of autogenous welding is being used so successfully in all the metal trades, many unsuccessful attempts have been made to weld malleable cast iron, and to those who have experienced disappointment, an explanation that recently appeared in the *Iron Age* of why their efforts failed, with an outline of a method by which these castings can be mended, should be of benefit.

Malleable castings are originally in the condition of hard, brittle, white cast iron that is subsequently made malleable by heat treatment, which effects a chemical change in the structure by decarbonization. This decarbonization is nearly complete at the surface, but in a lessening degree toward the center, giving the outside portion the texture of mild steel while the inner portion may retain the qualities of cast iron. It is useless, therefore, to follow the welding method prescribed for either material.

To mend successfully a malleable casting the welding material should fuse at a lower temperature than the casting, and its adherence, bonding qualities, physical strength, and ductility should closely resemble the original casting.

In preparing the work, the fracture is chipped away in the form of a V groove, and the part surrounding the fracture is then heated with an oxy-acetylene torch to a bright red, and sprinkled with a bronze flux, followed by a few drops of Tobin bronze melted from the welding rod. If the bronze remains in a little globule the work is not hot enough, but if it spreads and adheres to the surface, the temperature is right, and the groove should be quickly filled, and at as low a temperature as possible. The behavior of the bronze affords a guide in regulating the temperature. This process cannot be called autogenous welding, but a malleable casting mended in this way is practically as good as one piece. It has about the same tensile strength and ductility as the original, and the process has the advantage of being very quickly performed.

Household Industries in the Philippines

THE scheme of increasing the earning capacity of the Filipinos of the lower classes by training the women in various household industries has made excellent progress. At one time it appeared doubtful whether the average standard of intelligence among these women was high enough to enable them to take up lace making, fine embroidery, and the like, with success. However, this question has been fully tested in the women's department at Bilibid Prison, where industrial instruction was recently inaugurated by Miss McGee. The female convicts were generally of low intelligence and untrained in the use of a needle, yet within four months a number of them qualified as efficient workers, and not one failed to develop the efficiency necessary to produce a marketable product representing at least a fair daily wage. Now a school of household industries has been established at Manila, providing for the instruction of about 300 women a year. The pupils are under obligation to return to their homes, scattered over the islands, at the end of the course of instruction, and to instruct the women of their communities in the same industries.

The Motor-driven Commercial Vehicle

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The Editor will endeavor to answer any questions relating to mechanical features, operation and management of commercial motor vehicles.

Driving All Four Wheels

By Ross Babcock, M.E.

THE efficiency of a commercial motor vehicle depends to an appreciable extent upon the tractive effort it can develop, and this is particularly the case with the heavy vehicles now so generally in use. For years the typical pleasure vehicle has been driven from the rear wheels, the front wheels performing only the function of steering the car except in so far as they support part of the weight.

This method of construction may be looked upon as a natural one; it follows the line of least resistance and solves the problem of propulsion and steering with the least complication and without engineering difficulty not easily overcome. And inasmuch as the development of commercial motor vehicles came after the development of vehicles intended largely for the pleasure of those who own them, it may be looked upon as natural that their construction follows closely the construction of their predecessors. Nine tenths of all the commercial motor vehicles produced are propelled through the rear wheels and steered only through the front wheels.

But with the loading of such vehicles to the extent that is now common, other difficulties than those of merely propelling and steering the vehicle came to light. For instance, it was discovered that for real efficiency it is essential properly to proportion the amount of weight carried by the four wheels. Where but two wheels are used to propel the vehicle this necessitates that the greater part of the load be centered over them in order to obtain the necessary traction.

Again, when the greater part of the load is centered over one pair of wheels, which is usually the rear pair, that part of the mechanism, unless constructed of proportionately stronger parts, is called upon to sustain excessive strains.

The advantages of the four-wheel drive vehicle over the vehicle in which only two wheels are driven are given as follows:

1. Tire economy.
2. More equal distribution of wear on mechanical parts.
3. Increased traction.
4. More equable power distribution.

Against these advantages must be balanced:

1. Engineering difficulties to be overcome.
2. Increased complexity of machinery.
3. Possible increase in maintenance cost (see No. 2).
4. Possible increase in care needed during life (see No. 2).

Taking up the advantages one at a time we find upon purely superficial examination that tire economy comes naturally by reason of the fact that the load and the driving wear are taken in proper proportion by all four wheels.

The wear upon mechanical parts is equalized to a greater extent when all four wheels do their share of the driving and load carrying than is the case where but two of the wheels both drive and support the bulk of the load.

The question of increased traction scarcely requires any enlarged discussion. In this respect, the heavy towing locomotive forms a homely analogy. Here all the available weight is placed over the driving wheels, and the number of these wheels is made as great as possible. The same holds good of the four-wheel drive truck, except that in this case the idea is carried still further; for in it all of the weight is centered over all the wheels and all the wheels drive.

The distribution of the power of the engine to all four wheels instead of merely to two of them appears to be quite logical, for whereas the driving wheels of an ordinary vehicle often are severely overtaxed by carrying both the dead load and the driving load, the front wheels, which carry but a fraction of the load, must under most ordinary conditions be undertaxed, if such a word may be used.

Under the head of disadvantages, the engineering difficulties which must be overcome, loom fairly large; here we have the problem of driving four wheels instead of two, and this may or may not necessitate the addition of some means of permitting a certain amount of flexibility between the relative speeds, not only of each of a pair of wheels, but between each pair of wheels complete. Nor is the ordinary type of differential mechanism entirely satisfactory.

Added to this we have the difficulty of providing some means of both driving and steering one of the pairs of driven wheels. This requires some sort of a universal joint or similar mechanism, which, of course, means increased friction and added wear and power consumption. The solution of the problem, of course, renders simple, or comparatively so, the steering of all four wheels as well as the driving of them, and this has a decided advantage where the vehicle is to be used in considerably congested traffic or in close quarters.

The other disadvantages may be grouped for they all hinge upon the increased complexity of the mechanical construction of the vehicle. There can be no doubt but that there are more wearing parts in a four-wheel drive than in a two-wheel drive vehicle.

The accompanying diagrams show how all of the most prominent American and foreign motor vehicle builders have gone about solving the problem of driving all four wheels.

Figs. 1 to 5, inclusive, show five of the methods of construction used by the recent contestants in the French military trials, and hence may be regarded as thoroughly representative of foreign practice.

In Fig. 1, which shows the Chatillon-Panhard, power is transmitted from the motor *A* through a gear set *B* and a single central differential *C* to the lateral shafts *D* through bevel gears and thence to auxiliary shafts *E* through bevel gears to vertical shafts *F*, and finally to the wheels through more bevel gears.

Fig. 2 shows another type of Chatillon-Panhard drive in which the arrangement is somewhat similar except that final drive from the radiating shafts *D* is by worm gears to the wheels.

Fig. 3 shows the method used in the Blum-Latil vehicles. In this case the power is transmitted from the motor *A* through a gear set *B* to "live" axles both front and rear, incorporating each its own differential *C*. Thence, the drive is taken by shaft *D* through universal joints to reducing pinions at the wheel hubs.

In Fig. 4 is illustrated the method of drive employed in the heavy Renault vehicles. Here, power is transmitted from the motor *A* through a gear set *B*, and thence by shaft *C* to "live" axles in each of which is incorporated a differential. At *E* there are universal joints at the side of the pivot pins of each of the wheels.

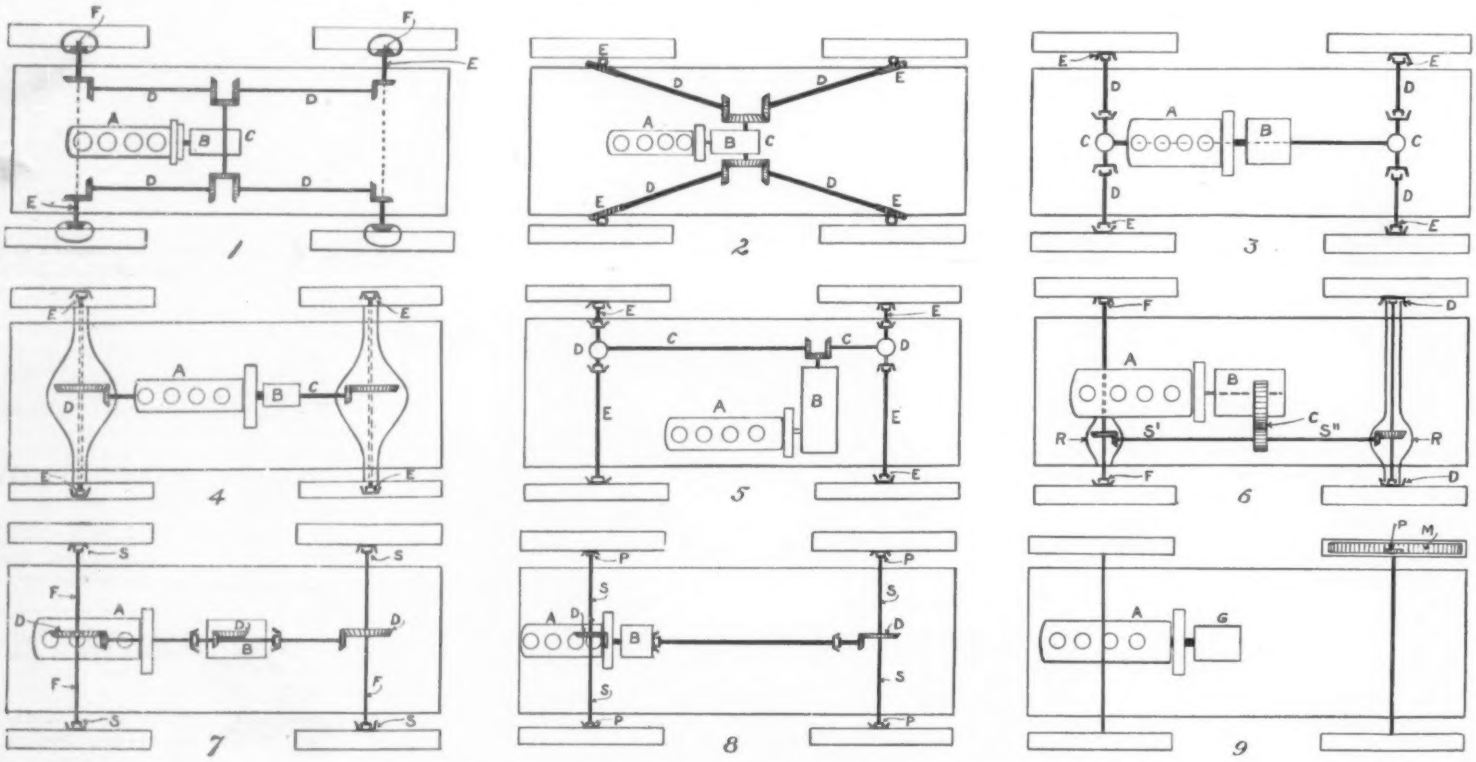
In Fig. 5, which shows the Schneider arrangement, the method is quite different. In this case the motor *A* is set well to one side of the chassis and the gear set *B* is located transversely. From the gear set power is transmitted through bevel pinions to the longitudinal shafts *C*, and thence through "live" axles, each with its differentials, to the wheel shafts; numerous universal joints are used to permit the necessary flexibility.

The arrangement which is shown in Fig. 6, and which represents a typical American design, is quite different. Here, there are two longitudinal shafts *S'* and *S''*, which drive through differentials *R* and wheel shafts to universal joints. From the motor *A* the power is transmitted through a gear set *B*, and thence by means of a "silent" chain to the longitudinal shafts *S' S''*.

In Fig. 7, the arrangement is somewhat similar except that the chain is eliminated. Power is transmitted from the motor *A* through a gear set *B* incorporating a differential *D*, and thence to "live" axles incorporating other differentials; there are three altogether. The "live" shafts are designated *F* and the wheel pinions *S*. These are universal joints.

Fig. 8 shows another typical American design that does not differ materially from the others. In this case the motor *A* is located well forward on the chassis and drives through a gear set *B* to differentials *D* on both front and rear wheel shafts *S* through suitable universal joints. The final drive to the wheels is through

(Concluded on page 154.)



Mechanical arrangement of typical American and foreign four-wheel drive trucks.

INQUIRY COLUMN

READ THIS COLUMN CAREFULLY. You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. *In every case it is necessary to give the number of the inquiry.* Where manufacturers do not respond promptly the inquiry *may* be repeated.

MUNN & CO., INC.

Inquiry No. 9383. Wanted the name and address of a manufacturer who can make clock movements suitable for fly trap. They must be furnished at low cost and must operate a belt for a period of from two to four hours, or more.

Inquiry No. 9384. Wanted the name and address of a Company that can manufacture a combined toothpick and toothbrush made of special wood.

Inquiry No. 9385. Wanted the names and addresses of manufacturers of machines used for perforating music rolls for automatic pianos.

Inquiry No. 9386. Wanted a device to prevent eavesdropping on party telephone line.

Inquiry No. 9387. Wanted the name and address of manufacturer of composition roofing for tops of freight cars that will stand reasonable wear and tear, and for extreme wet weather and hot tropical climate.

Inquiry No. 9388. Wanted the name and addresses of manufacturers of a fiber board, which is absolutely smooth on both sides, not subject to warping and free from any imperfections such as ridges or small irregularities. Board should come to about 5 ft. wide by 5½ ft. long, and run from ⅛ to ¼ of an inch in thickness, and must be reasonably economical. A board of hard rubber would be exactly what was required, only the expense is too prohibitive to make its use practical.

Inquiry No. 9389. Wanted the name and address of manufacturers of valves, cyclinders, recording gauges, filling and weighing stands and all material and appliances which enter into the manufacturer, transportation and sale of compressed gases.

Inquiry No. 9390. A syndicate of gentlemen desire to get in touch with an inventor or manufacturer of some small patented article with a view of placing the same on the market. Large capital and expert sales force if the invention or article stands examination. Automobile specialties preferred.

Inquiry No 9391. Wanted the name and address of makers of plants for the utilization of by-products from sawdust, also waste wood.

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel.

COMBINED SUSPENDER TAB AND BELT LOOP FOR TROUSERS.—A. LEIGHTON, Erie, Pa. The purpose here is to provide a flexible tab, the lower portion of which is secured to the inside of the waistband, and the upper portion of which is adapted to be turned down upon the outside of the waistband, this latter portion of the tab and trousers being provided with co-operating fastening means whereby to secure the tab in turned down position in such manner as to form a belt loop.

KNITTED COLLAR FOR VESTS AND COATS.—F. G. CURTIS, care of J. H. Rice & Friedman Co., Milwaukee, Wis. The general objects of this invention are to provide a knitted collar for garments to which it is knitted in a suitable manner, so that the collar will have the proper set when turned down, yet snugly fit around the neck when turned up, the front ends of the collar being provided with a snap fastener so as to closely fit the front of the neck when turned up.

Pertaining to Aviation.

BIPLANE.—E. W. F. HERRMANN, 1200 Hays St., San Antonio, Tex. The principal object of the inventor is to provide a flying machine having a relatively high degree of stability and effective supporting surfaces proportionate to the relative small area of the supporting planes. Further, to dispose a pair of propellers in such position as to give the greatest lifting effect to the machine, and to so dispose the propellers as to obtain the greatest efficiency.

Of General Interest.

HOLDER AND STERILIZER FOR DENTAL BURS.—H. J. FRIES, 1002 N. J. St., Tacoma, Wash. This invention comprises two principal but intimately related parts, namely, a holder proper for burs or drills kept in stock, and a combined tray, or holder, and sterilizer for such burs or drills as the dentist may require for immediate use.

GREASE CUP.—T. O. ORGAN, 116 W. Seymour St., Germantown, Pa. This cup employs a plunger to discharge the grease, and is so constructed that a rigid stem or shank of minimum length may be formed between the cup and the part to be lubricated, thus greatly reducing or overcoming the liability of breakage under centrifugal force.

Hardware and Tools.

NUT LOCK.—J. G. SCHNEIDER, York, Pa. Address Charles A. Hawkins, 42 W. Market St., same place. This invention is embodied in a jam or locking nut having a body formed of a soft elastic material such as cork, and an inclosing casing of thin sheet metal, both of which are compressed into conical form engaging the thread of the bolt to which the main nut is applied.

HAMMER.—J. F. OVERCASH, Primghar, Iowa. This power hammer is capable of use with the ordinary blacksmith's anvil, wherein mechanism is provided for controlling the power of the blow, and for controlling the movement of the hammer, so that the blow may be delivered upon any part of the work.

Heating and Lighting.

DRILLING BIT.—J. E. PROSSER. Address Edwin R. Perry, Tulsa, Okla. The purpose here is to provide a bit especially adapted for use in drilling deep wells, wherein the bit is provided with water courses extending from the connected to the cutting end in spiral form. When dull, the cutting edge may be sharpened in the usual manner.

PIPE TONGS.—J. DE W. MEREDITH, care of Petrolia Machine Shop Co., Burkburnett, Tex. This tool is especially adapted for use with vertically arranged pipes, wherein flexible clasping mechanism is provided, capable of being quickly arranged to encircle the pipe or to release the same, and having gripping mechanism to engage the pipe evenly and uniformly.

DAMPER.—G. WOLF, 419 E. 22nd St., New York, N. Y. This invention provides a very minute regulation of draft in the combustion chamber of a furnace, steam boiler, heater, or stove, so as to insure a proper combustion by a mingling of the oxygen of the atmospheric air with the combustible gases before the latter escape through the smoke pipe and flue, and at the same time permitting the escape of non-combustible gases and preventing the same from being discharged into the rooms or building being heated, and thereby avoiding the casualties and odors which otherwise result.

THERMOSTATIC PRESSURE VALVE.—M. LEWLESS, care of J. J. McGovern, 277 Moffatt St., Brooklyn, N. Y. This valve is adapted for particular use in connection with a portable radiator heater, although the valve may be designed for use with other heating systems or storage devices wherein it is preferable or necessary automatically to cut off a supply of fluid matter, or, to cut off the supply of fuel to a burner for the heater.

Household Appliances.

STOVE TOP SUPPORT.—G. E. HEIDBREDER and A. OHNEMUS, Quincy, Ill. Address Excelsior Stove Mfg. Co., same place. The main object here is to provide a support having a base provided with a socket to receive the support, said socket permitting the shifting of the position of the support, thereby permitting it to enter farther into the socket so as to lower the top of the support while holding the same firmly locked in its shifted position.

Machines and Mechanical Devices.

PLATEN ROLLER RELEASE.—G. M. MOSHER, Dillon, Mont. This invention provides releasing mechanism for enabling the operator to release the platen roller, or in other words, to render it free from the mechanism ordinarily used for actuating it, thus enabling the platen roller to be turned in either of two directions, independently of the mechanism for actuating it during the general operation of the typewriting machine.

AUTOMATIC MULTIPLE CHUCK DRILL PRESS.—J. N. LANDAU, 101 W. 117th St., New York, N. Y. In this chuck drill press either of the chucks or tool-holding devices may be brought into successive coupling position to be rotated or operated from a single working spindle, the improvement being designed to be applied to machines which are now generally constructed, or to a machine having a specially mounted and driven spindle.

Railways and Their Accessories.

CAR WHEEL.—J. SLATTERY, 58 Chrome St., Chrome, N. J. The object in this case is to provide an improved wheel structure wherein a solid center is presented and a wearing rim connected with the periphery thereof. Another object is to provide a wheel in which is presented a locking member for the wearing rim or tire, whereby the parts are rigidly connected together.

Prime Movers and Their Accessories.

TIDE MOTOR.—J. ISHII, 69 Westland Ave., Boston, Mass. The invention relates to tide motors, and the object is to provide certain improvements in devices of this character both with respect to the float and its controlling means and the mechanism whereby to transmit and store the power generated by the rise and fall of the float.

MULTICYLINDER INTERNAL COMBUSTION ENGINE.—S. H. HART, 41 Maiden Lane, New York, N. Y. Among the objects in view in this patent are: to construct a water jacket for engines as a single or block casting irrespective of the number of cylinders; to permit the use of classes of metals for the cylinders and jacket; to provide a packing for the joint between the cylinder and jacket to prevent dislodgment of the packing by shock of explosion; and to provide a separable head for said jacket and cylinder for securement upon said jacket to lock the cylinder therein.

GRINDING TOOL FOR GAS ENGINE VALVES.—C. L. BALDWIN, care of M. Casey, Almond, Wis. An object of this inventor is to provide a hand tool having a valve-engaging head connecting with a stem or shaft to which rotation is imparted by one hand of the operator through suitable means, while pressure is exerted through the tool on the valve by the other hand so as to hold the valve in grinding relation to its seat.

Pertaining to Vehicles.

TOOL FOR REPAIRING TIRES.—P. E. ERICKSON, Port Chester, N. Y. This invention relates to tools or appliances for repairing pneumatic tires, and has particular reference to such tools, having the capability of ease and reliable manipulation for insertion and for insuring their being held securely in proper position during the treatment of the tires.

SLED BRAKE.—C. W. FOOTE, Rochester, Mich. This brake will engage the snow under the runners of the sled and thus prevent the forward movement thereof. The brake is normally suspended on the sled in such position that it will be above the level of the snow, and so arranged that it can be controlled by the person on top of the load, and allowed to move downward beneath the runners to give the desired result.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Driving All Four Wheels

(*Concluded from page 152.*)

universal joints and spur gears *F*.

Obviously, the use of electricity renders comparatively simple the application of the drive to all four wheels, and it is perhaps surprising that a greater number of makers have not taken this construction up. Fig. 9 shows what is probably the most successful of the very few electric four-wheel drive vehicles there are on the American market.

In this case the motor *A* is direct connected to a small electric generator *S*. This generator in turn is connected through a suitable controller with motors which are incorporated in each of the wheels of the truck. In this respect, it should be emphasized, that in this particular system, the motors are directly within the wheels of which they form an integral part.

Motor Truck Notes and Queries

E. P. O. writes: "While traveling through a certain section of the South recently, I observed several heavy trucks at work on a large excavation. They seemed to be provided with a special type of broad, flat wheels that enabled them to work in a soft surface with the greatest of ease. I would like to know more of the details of these trucks."

A. So far as the power plant, transmission, and frame are concerned, these trucks of which you speak were of the same kind that you will notice frequently on the streets of any large city. The ordinary wheels with their rubber tires, however, had been replaced by the special type of broad-rimmed tractor wheels, similar in principle to those used on the steam traction engines, although much smaller because of the high speed at which the gasoline engine does its work the most efficiently. These trucks that you saw were virtually then gasoline tractors, and they are used on many of the large farms for plowing, harrowing, and other agricultural operations. When desired, transverse flanges may be placed on the rims of the wheels to enable the truck to secure better traction on slippery road surfaces when it is hauling a heavy load distributed in three or four trailers. We believe that the type of tractor that you saw at work in the excavation is also provided with a power winch that is operated by the gasoline motor. This may be used for pulling stumps, hauling the truck out of a mud hole, loading and unloading heavy weights, and many other forms of contractor's work.

J. A. S. writes: "Our 1,000-pound delivery car is provided with spark and throttle control at the steering post, but the driver was formerly the chauffeur of a pleasure car having a foot accelerator as a supplementary method of control. He claims that the use of a foot accelerator enables him to handle the car to better advantage. Can such be applied to the majority of cars not originally so equipped?"

A. There are several foot accelerators on the market that can be attached to the floor boards of almost any make of car. Some of these are in the form of a pedal, while others are similar to the notched arc of a circle projecting a short distance above the floor board. To operate this latter type, the foot is merely slid forward to accelerate, and lifted slightly to throttle—the spring returning the arc to its closed position as soon as the pressure is removed. When installing the foot accelerator, it is well to connect the steering post throttle with the latter by means of a chain so that the motor can be accelerated by the foot without affecting the position of the hand regulator. When this is done, the hand throttle may be used to set the minimum speed to which the motor will return when the foot accelerator is released. It is probable that, if your driver is familiar with this method of control as used on pleasure cars, he could obtain better service from the delivery truck if it, also, were so equipped.

The Heavens in September

(*Concluded from page 150.*)

quadrature west of the Sun on the 25th, and rises at 10:30 P. M.

Uranus is in Capricornus, his position on the 2nd being 20 hours 44 minutes 26 seconds right ascension, and 18 degrees 48 minutes south declination, and on the 30th, 20 hours 41 minutes 39 seconds, —18 degrees 58 minutes. He crosses the meridian about 10 P. M. at the beginning of the month and 8 P. M. at its close, and is well observable. Neptune is in Gemini, and is observable shortly before sunrise.

The Moon is full at 9 A. M. on the 4th, in her last quarter at 1 P. M. on the 12th, new at 4 P. M. on the 19th, and in her first quarter at 7 A. M. on the 26th. She is farthest away on the 9th and nearest on the 21st.

There is a large partial eclipse of the Moon on the 4th, during which more than five sixths of the Moon's diameter is obscured by the Earth's shadow. This eclipse is invisible at Washington and throughout the eastern half of this country, but partially visible on the Pacific Coast, and completely so throughout most of the Pacific and in eastern Asia. By Pacific standard time, the Moon enters the Earth's shadow at 4:16 A. M., and the middle of eclipse comes at 5:54, so that the Moon will set and the Sun rise before it is half over.

Comets.

Delavan's comet is now well placed for observation. Its track during the month may be defined by the following rough positions:

	R. A.	Dec.
September 1....	8h. 23m.	+ 49 deg.
September 17...	10h. 17m.	+ 50 deg.
October 3......	12h. 48m.	+ 43 deg.

On September 5th it will pass close to the north of ι and κ Ursæ Majores; on the 21st it will be on the line of the "Pointers" in the Great Dipper, and about 8 degrees south of them, and on October 4th it will be some 3 degrees north of α Canam Venatecorum. Its high northern declination will bring this region well up into the northeastern sky before sunrise, and the best time to observe it will be between 3 and 4 A. M.

This comet will probably be of the fifth magnitude or brighter and easily visible to the naked eye, but there is as yet no evidence available to the present writer to justify a more precise prediction.

Later elements of Neujmin's comet, based upon more numerous observations covering a longer interval, show that the provisional orbit given last month requires extensive modifications. It appears now that the perihelion passage occurred August 11th, at a distance of 346 million miles from the Sun—nearly four times that of the Earth. This is one of the greatest perihelion distances on record, and the comet must be a big one to be visible at all so far off. The Earth is moving away from it, and it is gradually growing fainter. As it was visible only in a large telescope at first, it is of little interest to the amateur observer; but it may be worth while to record the predicted positions: September 1st, 17 hours 26 minutes 41 seconds right ascension + 1 degree 54 minutes 44 seconds declination; September 17th, 17 hours 29 minutes 6 seconds right ascension —0 degree 26 minutes 50 seconds declination.

It is more than 300 million miles from the Earth, which explains its great faintness.

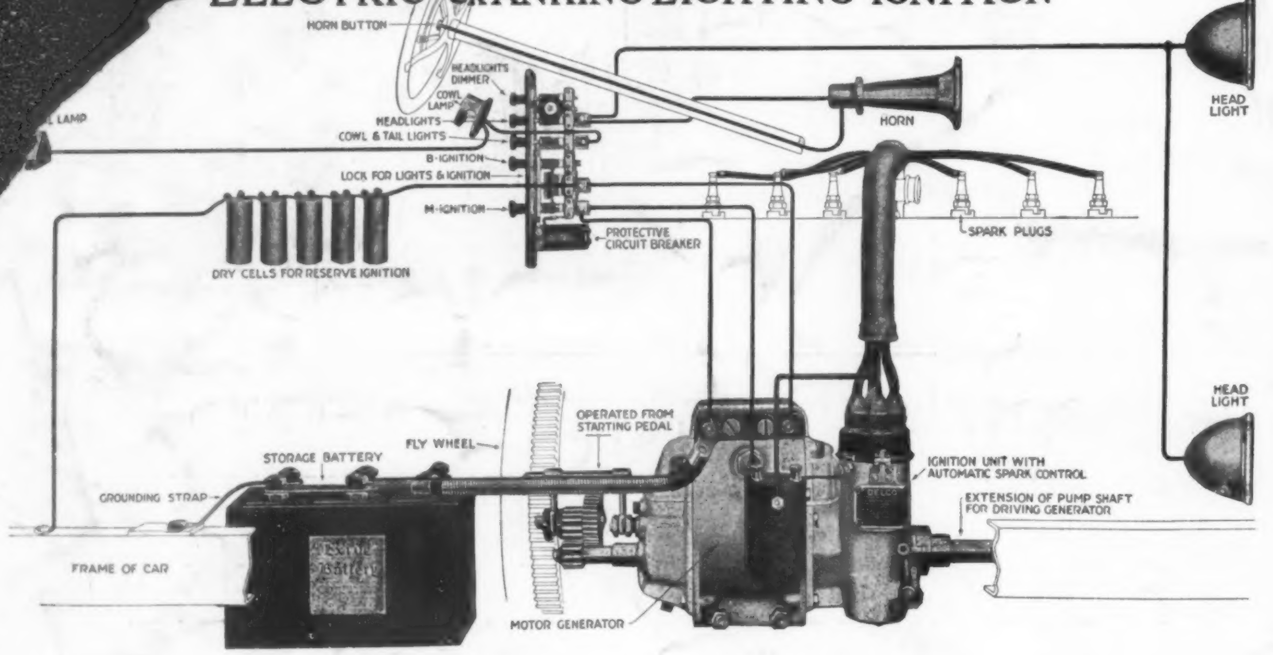
The comet of 1729, almost the only one whose perihelion distance is equally great, had an orbit which was similar in some respects, but as the longitude of the node in the two cases differs by nearly 90 degrees, and the inclinations are about 20 degrees, the two orbits lie in very different positions in space, and this cannot be a return of the earlier comet.

Southport, Conn.

Compound Railroad Tie.—A railroad tie in which a metallic jacket is shrunk upon a wooden core is shown in patent No. 1,102,693, to Charles Lynn Seyler, of Academy, W. Va.

DELCO

ELECTRIC CRANKING LIGHTING IGNITION



Simplicity is the Keynote of the Delco System

Study the wiring diagram illustrated above.

It shows all the wires there are in a Delco equipped automobile.

Note the simplicity of it—the apparent strength and character indicated.

You will find slight deviations from this diagram to meet the engineering and manufacturing requirements of the various motor car companies. But, in all essential details the diagram is standard.

The Delco system is a complete electric cranking, lighting and ignition system.

It includes also—

A reserve ignition—

A connection for horn and extra lights when desired—

A dimming feature for headlights—

A protective circuit breaker to prevent possible damage from short circuits—

A locking device for both ignition and lights.

The automatically controlled generator provides a high charging rate at low car speed and lower charging rate at high speed thus insuring a well charged battery under ordinary operating conditions, and preventing over-charging at the hands of a fast driver.

The automatically controlled ignition insures a properly timed spark at all engine speeds.

And with all these features the Delco System is remarkably free from complications.

It has less wiring, in fact, than was once used for ignition alone.

This combination of efficiency and simplicity is made possible by the single unit, single wired, grounded system.

The Delco System was the pioneer in the electric cranking field.

Three years ago the first electrically cranked car appeared.

It was Delco equipped—and it revolutionized the automobile industry.

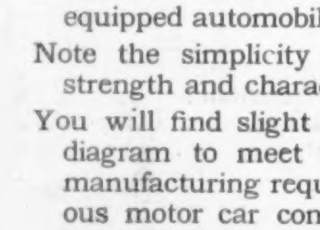
Today 154,000 owners are driving Delco equipped cars.

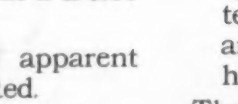
The Dayton Engineering Laboratories Company, Dayton, Ohio

1—Delco-Exide battery made to withstand rough usage and give constant, efficient service.

2—Combination Switch—controls entire electrical System. Strong, simple and very compact.

3—Motor-Generator, furnishing current and power for starting and lighting and including entire ignition system.





These three units comprise the entire Delco System—cranking, lighting and ignition